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# OUR INSECT ALLIES

THEODORE WOOD

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BY

## THEODORE WOOD,

AUTHOR OF "PRACTICAL LESSONS ON INSECT LIFE," AND
JOINT-AUTHOR OF
"THE FIELD-NATURALIST'S HAND-BOOK," ETC.

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# PREFACE.

FOR many years after the study of entomology began to occupy the attention of scientists, it was generally, although tacitly, received as an axiom that the words "insect" and "destroyer" were practically synonymous. It was seen that certain insects were injurious to the interests of man, owing to the ravages which they committed upon his crops, and from this fact it was inferentially, but illogically, argued that as the one so must be the many, the result being that these creatures, as a group, were ranked as the natural enemies of the human race.

As the tide of discovery swept on, however, it was found that this inference was far too sweeping, and that many insects, instead of being the foes, were in reality the friends of mankind. And with every succeeding year this latter group increased in dimensions until it attained to proportions far exceeding the limits which could have been assigned to it by the wildest of dreamers.

I think, however, that we may take a yet more comprehensive view of the benefits conferred upon us by insects, and may even assert, with much show of reason, that not only is no insect absolutely injurious to our interests, but that there is none which, were we fully acquainted with its life-history, might not in some manner be utilised for our advantage.

To bring forward absolute proofs of such a theory is well-nigh impossible in the present state of scientific knowledge. But, taking into consideration the revolution which recent investigations have already caused with regard to the ideas formerly held concerning insects, we may, I think, reasonably hope that the day is not far distant when these beings, as a body, shall be viewed in a light totally different from that in which they were once regarded.

Such has been the case with animals far higher in the scale than are the insects. For instance, we now consider the rook, the starling, the kestrel, and the owls, as our allies, recognising the fact that our previous notions concerning them were totally erroneous. And, as it is with these, so it is with the insects, a careful examination into their life-history showing us that, unless we are thoroughly acquainted with every stage of their existence, we should hesitate before killing them, lest, when we think that we are ridding ourselves of an enemy, we may be destroying one of our best friends, who would be our ally if permitted to perform the duties assigned to it by nature.

UPPER NORWOOD, *March*, 1884.

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# OUR INSECT ALLIES.

## CHAPTER I.

### INTRODUCTORY.

NOTWITHSTANDING the daily increase of scientific knowledge, there are yet comparatively few, even among the educated classes, who thoroughly realise the fact that insects are not necessarily the foes of mankind. The popular idea concerning an insect is that it is a being created only to be destroyed, and, unfortunately, this theory is only too often carried into effect.

We notice a beetle crawling at our feet, perhaps, or a fly upon the window-pane, and immediately crush it without waiting to inquire whether or not it merits such a fate. For all we trouble ourselves to ascertain to the contrary it may be a creature of the greatest service to us, working for our good throughout its active existence, although, possibly, its actions are carried on in so secret a manner that we do not recognise their value until we come to examine the history of its life.

Some few insects, it is true, more fortunate than their fellows, escape the general condemnation.

Superstition protects one or two, such, for instance, as the ladybird, which, from our earliest childhood, is represented to us as a being which it is "unlucky" to harm. And although in after years we recognise the absurdity of the notion, the old impression yet clings to us, and there are few, indeed, who would wantonly kill a ladybird, even in circumstances where any other insect would meet with instant death.

Some, such as the butterflies, are spared on account of their beauty and supposed harmlessness. But, as a general rule, the popular verdict at once goes against an insect, the usual preliminaries of accusation and trial being altogether dispensed with.

It is true enough that there are many insects which, in their different ways, are inimical to civilised man. Some destroy his crops; some devour his grain as it lies stored up in his barns until required for use; others attack his cattle; and so on. But it must be borne in mind that the hostility of these creatures to man is, in a great measure, a result of his civilisation, and is not a direct provision of nature.

For civilisation is not a natural state. Man is not civilised when he comes into the world, but becomes so in after years simply through the agency of education. Such being the case, we can scarcely look upon those creatures which his civilisation converts into enemies in the light of foes provided by nature.

And that the enmity of these insects to man is induced by his civilization is a fact so self-evident that proof is scarcely required. The savage, pure and simple, does not suffer from their attacks. He cultivates no crops, and is, consequently, not influenced by the ravages of creatures which are so injurious to the interests of more civilised races. He stores up no grain, and is therefore uninjured by the depredations of insects which depend upon that grain for subsistence. He keeps no flocks, and so sustains no losses from the death of cattle which have fallen victims to the attacks of the multitudinous insects which are parasitic upon them. And, indeed, we can scarcely consider even those minute beings which are included under the collective title of "vermin" as his natural enemies. It is impossible, indeed, to suppose that they were placed upon the earth for the sole purpose of causing annoyance to mankind.

For, if such be the case, how can we account for the numberless millions of these creatures which never meet with man during the whole of their existence, as must be the case with by far the greater proportion of them?

If we make our way into the thickest forests, where the human form is not seen once in a century, we find every bush and tree swarming with parasites, which are only too ready to transfer themselves to the passer-by, but which, for generation after generation, must fail to meet with an opportunity for doing so. It is not as though their natural food consisted of the blood of either man or beast, which is to them, in fact, merely a luxury—a sort of dram-drinking—preferred when attainable, but by no means a necessity of life. As a general rule they feed upon vegetable juices alone, and are able to subsist upon such diet for countless generations, a curious proof of which fact occurred not very long since in the West Indies.

Upon examination of the apparatus used for the purpose of raising masts into their position in vessels, it was decided that the "sheers" then in use, and which had been standing for nearly sixty years, should be removed and replaced by new ones, which operation was according performed.

When, in the process of demolition, the metal capping was taken from the apex of the instrument, a most extraordinary sight presented itself. The whole of the space between the metal and the wood was found to be closely packed with bugs, which, as blood, human or otherwise, was not procurable, must have existed there for many generations, feeding only upon the juices which they had been enabled to extract from the wood.

This curious discovery affords us an ample proof that these insects were not created for the exclusive purpose of causing annoyance to mankind, and that the persecution of man is only incidental to those which may happen to cross his path.

More than this. Not only are those creatures which we are accustomed to consider as our natural enemies almost neutral as far as the savage is concerned, but some which are among the direst plagues of civilised man are to him a positive blessing.

Let us take, for example, the Locust.

We can scarcely imagine, from our point of view, a more terrible enemy than this insect, which, appearing in countless myriads, leaves the country over which it passes as bare of vegetation as though it had been scorched by fire. But what does the savage see in the same insect? Not a foe, for he has no crops, and, therefore, nothing to lose. On the contrary; instead of being looked upon as an enemy, the winged destroyer is regarded by him with very different feelings, for in it he sees a welcome addition to his ordinary diet, the monotony of which is seldom varied by a dainty procured with so little trouble to himself. And, as with this, so with others, which, while they are the bane of civilized man, stand in a totally different position with regard to the savage.

Taking it for granted, then, as I think we fairly may, that insects are not our natural foes, it is also true that those which are hostile to us increase in numbers in a ratio proportionate with the growth of our civilisation. As soon as man rises sufficiently in point of intellect to till and sow the land, the insects which find their food in the plants which he cultivates become his enemies. And, as he progresses, and places a greater number of plants under cultivation, his insect foes naturally increase in a corresponding degree.

Let us see what would be the result, even with ourselves, were we suddenly to discover that some plant —say the common stinging-nettle—which we had always been accustomed to look upon merely in the light of a weed, possessed properties which would render it of value to mankind. It would immediately be placed under cultivation, and all those creatures which find their food in its leaves, stems, or roots would thereby be transferred to the category of our insect foes, whereas at present we regard them in the light of friends. Thus the Admiral and Tortoiseshell butterflies, the Peacock, and many others which we had previously considered as merely neutral insects, would at once assume a very different position, and would be kept down by every means in our power. But by no stretch of imagination could we consider them as our natural foes, but could only recognise their hostility as a necessary consequence of our advance in civilisation.

Again, it must be remembered that the plants upon which our so-called "insect enemies" feed are, in a state of nature, not vegetables, according to the generally received sense of the word, but weeds. It is not until man steps in, and by long and careful cultivation and selection raises them to a higher standard that they become of service to him, and repay him for the trouble which he has expended upon them.

The same is the case with our fruits.

Few of these are of any particular utility, even in the most favoured tropical climate, in their wild and natural state, protracted and careful cultivation being necessary before they attain to the degree of perfection in which we now see them. We care nothing for the depredations of insects upon their wild prototypes, but are yet unreasonable enough to consider the very same insects as our natural foes when they attack the trees in our orchards, which are nothing more than the cultivated and improved descendants of those trees which nature appointed as their food. We never trouble ourselves, for example, concerning any damage which may be caused by insects to such trees as the crab-apple, the wild cherry, or the sloe; and these are the progenitors of our apple, cherry, and plum-trees.

Yet, when the cultivated descendants of the very same trees are attacked in our orchards, we grumble bitterly at the havoc wrought by our "insect enemies." These insects become our enemies by our own act in cultivating the plants upon which they depend for food, but are not appointed as such by the hand of nature. Indeed, it is scarcely fair to include them under the heading of "enemies" at all, and we can only do so for want of a better title.

. . . . .

As for our insect friends, they are far more numerous than any one who had not studied the subject could be expected to believe. For, as a general rule, their work does not appear upon the surface, but is carried on so secretly that it is not until we institute careful investigation into their life-history that we have any notion in how great a degree we are indebted to our unrecognised little benefactors.

And in this investigation consists the real science of entomology, the habits and work of its subjects being of far greater importance than the merely supplementary details of anatomy. Structure in every living being is subservient to instinct, and not *vice versâ*. But, unfortunately, this principle is not so well recognised as it should be, and we have, in consequence, hundreds of so-called naturalists whose efforts are centred in the sole idea of describing and tabulating species, instead of in the study of the life-history of the insects which they profess to understand. To these an insect loses the greater part of its interest when it has once been described, and is then considered as chiefly, if not entirely, of service as a cabinet specimen for comparison with allied species.

It is true that without some definite system of arrangement we could do little or nothing in the study of entomology. Insects must be divided, firstly, into orders, then, roughly, into groups, then into families, and, finally, into genera and species. But, when this task is once satisfactorily performed the labours of the systematist are in great measure completed, and there can be no reason for constantly working over old ground in the manner adopted by so many naturalists.

Of late years, however, a great improvement has taken place in this respect. Entomologists are beginning to recognise the fact that the nomenclature, description, and tabulation of species are, after all, only supplementary to the study of the history of their life, and the influence, if any, which they exercise upon mankind. New workers in this field come forward almost daily, and it is only necessary to compare the entomological journals of the present day with those of fifteen or twenty years back to see how great an alteration for the better has been brought about.

Instead of a mere mass of dry descriptions, varied only by long lists of captures of little interest and less utility, we have both valuable and interesting papers upon the economy of insects, in which the history of each species is traced from the time when the egg is deposited until that when the perfect insect, having performed its last duties, and provided for a future generation, dies in order to make way for its successors. Then, we have the accounts of experiments made with regard to those insects which are really inimical to mankind, showing how their ravages may be checked, or even altogether prevented, by taking the necessary precautions in due time; together with many other articles of kindred and equally useful nature. Science is no longer a mere accumulation of dry facts, complicated by pedantic and often meaningless phraseology, but has been proved capable of affording instruction and interest not only to the few, but to the many.

WHEN we come to consider those insects which may be regarded as our benefactors, we are at once struck by a curious fact, namely, that, with few exceptions, the services which they render to us are wrought *indirectly.* We have the bee, it is true, from which we obtain honey and wax; we have the silkworm, whose produce is so valuable an article of commerce; the lac insect, from which we procure sealing-wax, and the basis of various varnishes; the cochineal insect, which affords us a valuable dye; the blister-beetle, or Spanish-fly, which is so largely used in medicine; and one or two others of less importance. But, with these few exceptions, our insect friends are friends only indirectly, although their services are none the less valuable to us on that account.

Another point which is sure to strike us is, that the good offices which these insects render to us are all due to the nature of their *food*. In nearly every case, in either their larval or their perfect condition, or, in many instances, in both, they prey upon other creatures which find place among the enemies of man, and, by their ceaseless operations, often save crops, &c., which must have otherwise been totally ruined; or, by removing putrid animal and vegetable matter, save us from the agues and fevers which would necessarily result were it allowed to remain.

In the former of these we have an instance of nature's great law of Destruction. Life, in some form or other, must perish in order that life may be maintained. No animal, great or small, is without its natural foes, which check its increase, and keep its numbers within proper limits. Sometimes, in our blindness, we fail to recognise this rule, and, by our vain attempts to improve upon nature, succeed merely in causing ourselves injury which might have been averted had we allowed the natural laws to run their course. We have to thank our own ignorance, and that of our predecessors, for example, for the prevalence of many of the destructive insects which annually infest our crops, for by killing the small birds we have greatly lessened the number of the agencies which kept these pests within due limits, and by thus disturbing the balance of nature have brought upon ourselves consequences of a very unpleasant character.

It is a curious fact, at any rate as far as insects are concerned, that the same causes which operate upon the development of any species in unusual plenty appear to exercise a similar influence upon its natural enemies, the plague of the one being thus counteracted by the superior numbers of the other. Upon this subject we shall subsequently have occasion to dwell at greater length.

The importance of such a law can hardly be overestimated, if we consider the vast influence which is often exerted in nature by an apparently insignificant cause. When we reflect that large islands are raised from the sea by the agency of animals of such minute dimensions as the so-called coral "insect," and that whole cities may be buried many feet underground by the labours of a creature seemingly so unfit for such a task as the common earth-worm, we shall scarcely feel surprise if we learn that similar beings are the appointed instruments for other and equally important operations.

The influence which may be exerted by insects has been touched upon by the late Charles Darwin in his "Origin of Species," page 56. He says:—"In several parts of the world insects determine the existence of cattle. Perhaps Paraguay offers the most curious instance of this; for here neither cattle, nor horses, nor dogs have ever run wild, though they swarm southward and northward in a feral state; and Azara and Rengger have shown that this is caused by the greater number in Paraguay of a certain fly, which lays its eggs in the navels of these animals when first born. The increase of these flies, numerous though they are, must be habitually checked by some means, probably by other parasitic insects. Hence, if certain insectivorous birds were to decrease in Paraguay, the parasitic insects would probably increase; and this would lessen the number of the navel-frequenting flies—then cattle and horses would become feral, and this would certainly greatly alter (as indeed I have observed in parts of South America) the vegetation; this, again, would largely affect the insects; and this, as we have just seen in Staffordshire, the insectivorous birds, and so onwards in ever-increasing circles of complexity."

Again, Bruce, the Abyssinian traveller, concludes that it is owing to the agency of insects that the African elephant has not increased in such numbers as to over-run the country; and Dr. Falconer puts forth a similar theory with regard to the Indian species, both animals being greatly annoyed by parasites, which by their continual persecution, and the loss of blood resulting from their attacks, so weaken their victims as to exert a considerable influence upon the multiplication of their kind.

IT is, of course, out of the question, in a work like the present, to give a full list and description of all the insects which, even in our own country alone, exercise a beneficial influence upon man. In the present imperfect state of our knowledge, indeed, it would be presumption to state that any insect is wholly inimical to him, although we may not be able to detect the good qualities which would compensate for the bad were we but possessed of sufficient knowledge to turn them to good account. With regard to some few insects, we have discovered that, although they may be harmful to us in one way they are yet useful in another, and that, at any rate under certain circumstances, the services which they render to us far outbalance the depredations committed by them which have caused us to rank them among our foes.

A good example of these we may find in the silkworm. Had we not discovered that this insect was valuable to us as producing a marketable commodity, we should never have taken it into domestication, so to speak. In that case, however, we must have ranked it among our enemies, for it would have proved destructive to the mulberry-trees in our orchards, thereby obliging us to keep down its numbers for the protection of our own interests. Here we have a direct instance of an insect, previously inimical, becoming of service to us owing to the increase of our knowledge.

Even so universally detested an insect as the common cockroach has its uses, for, besides acting as a scavenger in a small way, it is the untiring foe of certain lesser and still more unpleasant creatures which sometimes find their way into houses. See what the late Mr. E. Newman tells us in the preface to his "Natural History of British Butterflies":—

"'Poverty makes one acquainted with strange bedfellows,' and my informer bears willing testimony to the truth of the adage: he had not been prosperous, and had sought shelter in a London boarding-house: every night he saw cockroaches ascending his bed-curtains; every morning he complained to his very respectable landlady, and invariably received the comforting assurance that there was not a 'black-beetle' nor a bug in the house, and if he *had* seen such a thing, he must have brought it to the house in his clothes; still he pursued his nocturnal investigations, and he not only saw cockroaches running along the tester of the bed, but, to his great astonishment, he positively observed one of them to seize a bug, and he therefore concluded, and not without some show of reason, that the cockroaches ascended the curtains with this especial object, and that the minor and more odoriferous insect is a favourite food of the major one."

The same author also quotes a passage from Webster's "Narrative of Foster's Voyage," in which it is stated that, unpleasant though they may be, cockroaches are actually welcomed on board ship, as they entirely clear the vessel of the smaller vermin which form so intolerable a nuisance. This report is also corroborated by other writers, more than one stating that, when the supply of cockroaches runs short, the sailors will actually beg for a quantity of specimens from the first ship with which they may happen to meet.

I mention these facts here as, the cockroach not being an indigenous inhabitant of this country, they cannot find a place in the body of the work. With regard to this insect, we may reasonably conclude that we have discovered some of the good features in its character which tend to counterbalance its disagreeable qualities; and we may, I think, infer that there is more than a possibility of doing the same with other noxious insects. A large field for investigation lies open before us, and we ought, at any rate, to consign no insect to the ranks of our enemies without endeavouring, by every means in our power, to ascertain whether it has not some compensating good qualities.

I do not, in the following pages, intend to treat of those insects already mentioned as being directly serviceable to man—such as the bee, the silkworm, &c. Their value must be already familiar to most, if not all, of my readers, and I shall therefore confine myself to a description of those whose services are less generally known and appreciated.

Neither can I touch upon the vast importance of the work performed by insects as regards the fertilisation of plants. Such a theme is far too wide to find place in a work like the present, and I am obliged, therefore, to be content with merely this passing reference to what must be universally acknowledged as a subject of the highest interest and importance.

But I shall describe those of our British insects which, although of service to us in an indirect manner only, yet exercise an appreciably beneficial influence upon ourselves and our interests. In some cases, the benefits conferred upon us by these insects are qualified by a certain amount of damage done in other ways; others, again, would seem to work us nothing but good. But, whether they be wholly, or only in part our friends, none will be included which have not been fully proved to merit a place in our esteem, and to possess a just right to the title of our Allies.

## CHAPTER II.

### BURYING-BEETLES AND THEIR KIN.

Burying-beetles and their uses—Manner in which work is performed—Reasons for burying food—"Rusticus" upon the Burying-beetle—Keenness of scent—How do insects smell?—Burying-beetles sometimes work in company, but do not act upon principle of combination—Different kinds of burying-beetle, and how to distinguish between them—Larvæ—Method of locomotion—Mode of undergoing change to pupal condition—Fetid odour exuded by burying-beetles—"Keeper's" trees—Services rendered by burying-beetles.

WE have here a group of beetles which, in their own way, are among the most valuable of all our insect friends. For, in both the larval and perfect stages of their existence, they feed upon putrid animal matter, which, if allowed to remain untouched, would certainly, by its putrefaction, be the source of disease.

This decaying matter they remove in a very curious manner. The parent-beetles, of course, visit it far more with the view of providing sustenance for their future offspring than of securing a meal for themselves, and must therefore take into consideration the necessities of their progeny. Now, the larvæ of these insects, in common with those of the generality of beetles, are not gifted with any great power of locomotion, and it is therefore manifestly impossible that they should be able to wander in search of further food should their supply become exhausted before their growth is complete. Again, their development is not very rapid, and some means must consequently be taken for preserving their food from decay for a period sufficient for their needs.

Now, if the offal selected by the parent-beetles were allowed to remain lying upon the surface of the ground, several causes would prevent it from fulfilling the necessary requirements. In the first place, some prowling animal might make a meal upon it, and so deprive the grubs at once of their food; and, even if this danger were avoided, the exposed nature of the situation would not suit the fastidious tastes of the larvæ, which are essentially creatures of darkness.

In the next place, and far more important, the weather would certainly cause a very considerable change in the carrion before many days had elapsed. If hot and dry, the carcase would shrivel up, and become so hard as to be useless as food; while, on the other hand, if the season were dull and wet, decomposition would take place with such rapidity that before the development of the grubs was half completed, their means of sustenance would have disappeared.

So, the parent insects set to work, and bury the carcase beneath the surface of the ground, where it is not only protected from enemies of various kinds, but, being unaffected either by heat or wet, is preserved in a state of semi-putrefaction until the grubs have reached their full development.

This interment is conducted with wonderful rapidity, the male seeming to perform the greater share of the work, while the female is engaged in the deposition of her eggs. The operation has been described with such fidelity by the late Mr. E. Newman, in his "Letters of Rusticus," that I cannot but use his own words.

"The burying-beetles hunt in couples, male and female; and when six or eight are found in a large animal, they are almost sure to be males and females in equal numbers. They hunt by scent only, the chase being mostly performed when no other sense would be very available—viz., in the night. When they have found a bird, great comfort is expressed by the male, who wheels round and round above it like an eagle; the female settles on it at once, without this testimonial of satisfaction. The male at last settles also, and the bird undergoes the scrutiny of four, at least, of the senses—touch, smell, sight, and taste—for their heads are continually diving among the feathers of the bird, and a savoury and ample meal is made before the great work is begun. After the beetles have appeased the calls of hunger, the bird is abandoned for a while; they both leave it to explore the earth in the neighbourhood, and ascertain whether the place is suitable for interment. If on a ploughed field, there is no difficulty; but if on grass or among stones, much labour is required to draw the body to a more suitable place. . . . .

"The operation of burying is performed almost entirely by the male beetle, the female mostly hiding herself in the body of the bird about to be buried, or sitting quietly upon it, and allowing herself to be buried with it. The male begins by digging a furrow all round the bird, at the distance of about half-an-inch, turning the earth outside. His head is the only tool used in this operation; it is held sloping outwards, and is exceedingly powerful. After the first furrow is completed, another is made within it, and the earth is thrown into the first furrow; then a third furrow is made, which being under the bird, the beetle is out of sight. Now the operation can only be traced by the heaving of the earth, which soon forms a little rampart round the bird; as the earth is moved from beneath, and the surrounding rampart increases in height, the bird sinks. After incessant labour for about three hours the beetle emerges, crawls upon the bird, and takes a survey of his work. If the female is on the bird she is driven away by the male, who does not choose to be intruded on during the important business.

"The male beetle then remains for about an hour perfectly still, does not stir hand or foot; he then dismounts, diving again into the grave, and pulls the bird down by the feathers for half-an-hour. Its own weight appears to sink it but very little. The earth then begins heaving and rising all round, as though under the influence of a little earthquake; the feathers of the bird are again pulled, and again the bird descends. At last, after two or three hours more labour, the beetle comes up, again gets on the bird, and again takes a survey, and then drops down as though dead, or fallen suddenly fast asleep. When sufficiently rested he rouses himself, treads the bird firmly into its grave, pulls it by the feathers this way and that way, and, having settled it to his mind, begins to shovel in the earth. This is done in a very short time, by means of his broad head. He goes behind the rampart of earth, and pushes it into the grave with amazing strength and dexterity, the head being bent directly downwards, and then the nose elevated with a kind of jerk, which sends the earth forwards. After the grave is thus filled up, the earth is trodden in, and undergoes another keen scrutiny all round, the bird being completely hidden; the beetle then makes a hole in the still loose earth, and, having buried the bird and his own bride, next buries himself. The female lays her eggs in the carcase of the bird, in numbers proportioned to its size; and, after this operation is over, and the pair have eaten as much of the savoury viand as they please, they make their way out, and fly away in quest of further adventures."

The sense of smell in these beetles must be wonderfully keen, for they seem able to detect the presence of their food from an astonishing distance, and to wing their way to the spot with unerring certainty. And yet, powerful as the organs of scent undoubtedly are, we can detect no trace of them, even upon the closest examination; and whether it be that the antennæ perform the functions of olfactory organs, or that, as the body of an insect is one large lung, so it is also one huge nostril, we are utterly at a loss to determine.

Personally, I rather incline to the latter theory, and for the following reasons :—

With the higher air-breathing animals, as is well-known, the sense of smell cannot be exercised without inhalation, the more or less rapid passage of air over the olfactory nerves being necessary in order to allow them to perform their functions. With regard to insects, however, it is difficult to see, supposing that the antennæ represent the olfactory organs, how the sense of smell can be experienced, for there is no method, save, perhaps, that of waving these antennæ to and fro, by which could be ensured the requisite passage of air over the extremities of the nerves. And such motions, in many species, would be impossible, the minute size of those organs entirely incapacitating them from employment by their owner in any such manner.

Again, were this theory correct, it would naturally follow that those insects with the largest antennæ would also be endowed with the most highly developed sense of smell. But this we do not find to be the case. The burying-beetle, for instance, and, in an even greater degree, the blow-fly, which detect the presence of the repulsive substances upon which they feed from a truly wonderful distance, have antennæ remarkably small in comparison with the bulk of their bodies, while others, which certainly seem to be endowed with no extraordinary olfactory powers, are yet furnished with large, plumed, and even branched antennæ, often far exceeding in length the body of their owner.

If, however, the sense of smell reside within the spiracles, or breathing-holes which are found upon the sides of the body, these difficulties are at once annulled, for the mere act of respiration would serve, as with ourselves, to acquaint the insect with any odours which might be floating in the air.

Should this be the case, however, the true functions of the antennæ would still remain a mystery to us, and we can only account for their presence by supposing that they are the organs of some sense not possessed by, and therefore incomprehensible to, ourselves.

Some persons have suggested that the sense which directs the insect is not that of smell as understood by ourselves, but is some power not possessed by man. This theory, however, is quite untenable. There are certain flowers whose odour exactly resembles the stench of putrefying flesh. Blow-flies are so completely deceived by this odour that they not only swarm upon the flower, but lay their eggs in it.

A popular French writer on natural history subjects, Jules Michelet, having noticed the fact that several pairs of burying-beetles are often to be found at work upon the same carcase, states in one of his books that these insects understand the principle of combination, and act upon it accordingly.

This theory, however, we cannot accept, for we might as well consider the blow-fly to work upon the same principle, when it assembles in numbers upon any putrefying substance, or the aphis to be actuated by similar ideas when it makes its appearance in our hop-gardens in such destructive hordes.

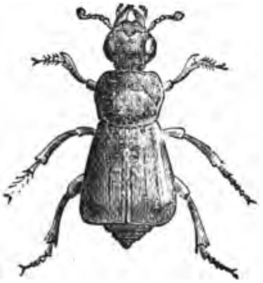
It is true enough that without combination these creatures could do little or nothing; but in all probability they are not aware that they combine. Each individual, or at most each pair of insects, works independently of the rest, and though, in a certain sense, the little creatures do act upon the principle of combination, the intelligence which directs their movements is not their own, but that of a far higher Power.

Burying-Beetle (*Necrophorus ruspator*).

SEVERAL species of burying-beetles are known to inhabit this country, one of the most plentiful of which is *Necrophorus ruspator*, a very handsome insect, and one that is sure to attract attention wherever it is seen. The ground-colour of this beetle is a deep black, the wing-cases being traversed by two broad irregular bands of rich orange, which form a striking contrast to the sombre hue of the remainder of the body. The apical segments of the abdomen are clothed with thick brownish down, which, curiously enough, does not appear to be injured either by the subterranean labours of its possessor, or by the repulsive nature of his food, retaining its pristine beauty even after he has been burrowing for hours in the soil, or tunnelling in search of food into the most putrid of carrion.

Another of these insects, *N. vespillo*, may be at once distinguished from the allied species, some of which closely resemble it, by a single glance at the hinder limbs, which are curved like those of a bow-legged man. This characteristic presents a never-failing point of distinction, for the curvature is so strongly pronounced that the insect can by no possibility be mistaken.

Another species, *Necrophorus humator*, is entirely black, with the sole exception of the club of the antennæ, which is of an orange hue. This is a much larger insect than the preceding, sometimes measuring as much as an inch and a quarter in total length, while *N. vespillo* seldom or never reaches an inch.



Burying-Beetle
(*Necrophorus humator*).

Several species of burying-beetle may often be found in company, more especially towards the end of summer, at which period of the year I have sometimes found as many as four distinct species in the carcase of a single rabbit.

The rapidity with which these beetles disappear when disturbed is perfectly astonishing. There is a scramble, a flash of orange and black, and the insects have vanished, some into the ground, others among the roots of the grass, and the remainder into the interior of the carrion upon which they were feeding. And, once having made good their escape, the very strongest measures will be required in order to drive them from their retreat, for their instinct teaches them to remain in hiding until long after the danger which threatened them may be supposed to have passed away.

The larvæ of the burying-beetles are all very similar in appearance, and are about as unlike their parents as can well be the case, being merely long fleshy grubs, with the rings, or segments, of the body very distinctly marked. The legs are so small in proportion to the size of the body as to be practically useless for locomotive purposes, a curious substitute being provided upon the upper surface of each segment in the form of a horny plate, with strongly toothed edges.

When the grub wishes to make its way through the soft and yielding substance upon which it feeds, it alternately elongates and contracts its body. At each movement the horny plates are raised, their jagged edges retaining the body in its new position until the tail is drawn up towards the head. This done, they are depressed, and a fresh movement takes place, the whole proceeding reminding one very strongly of the manner in which a snake travels over the surface of the ground, or a worm through the soil beneath.

When full-fed, at which time they are about an inch and a half in total length, these larvæ construct for themselves a kind of underground cell, in which they change to the pupal condition, remaining therein until their development is complete, and the time comes round for them to make their appearance in the world as perfect insects.

In common with most of the insects which find their food in decaying animal or vegetable matter, the burying-beetles possess the power of exuding at will from the mouth a liquid of the most disgusting odour, which clings to everything with which it comes into contact, and which can hardly be removed even by the most careful and repeated lavations. It is probable that this fetid fluid is in some way caused by the putrid nature of the diet of the insect, as it is entirely wanting in those specimens which have but just emerged from the pupa, and also in those which have been deprived of food for any length of time. It is far less powerful, too, in those beetles found feeding upon the carcases of the smaller birds and quadrupeds, while in those taken from the dead bodies of larger animals it is developed in its most offensive degree.

Even after death the insects retain their disagreeable odour for a considerable space of time, and it is therefore advisable, when obtaining specimens for a collection, to select only those found feeding upon carcases of small size.

What the object of this powerful and disagreeable odour may be we cannot tell with any degree of certainty. It may be that it is distasteful to the insectivorous birds, and therefore secures to those insects which possess it exemption from their attacks. Yet, if this be the case, how can we suppose the insect to be aware that an odour, which can scarcely be unpleasant, and may very possibly be imperceptible to itself, should yet be repulsive to its natural enemies? It may, of course, have other objects to fulfil, the nature of which we cannot conjecture. But, if it be used solely for purposes of defence, we can only suppose that it is instinctively put forth by the insect without any notion of the manner in which it may be of service.

And this, if true, would be by no means an isolated instance. Nature seems in many cases to have endowed her creatures with weapons, either of offence or defence, with the exact application of which we cannot but suppose them to be ignorant.

Let us take, for example, as an instance of the former, any venomous snake. The animal cannot be aware that within its head are glands, secreting a fluid which is poisonous when introduced into the blood; that these glands communicate with its fangs; that the fangs are perforated throughout their length; and that, if an animal sustain a wound from these fangs, the poison will be introduced into its system and shortly cause its death. It is taught by instinct to inflict the wound; the same subtle medium also informs it, probably, that in so doing it has sealed the doom of its victim. But it cannot know how or why it has done so, any more than the burying-beetle knows for what reason the insectivorous birds abstain from persecuting it.

As an example of the second class we may take the "looper" caterpillars, to be found on almost every tree and bush. As is well-known, they are in the habit of clinging to the branches of their food-plant by the hinder feet only, and stretching their stick-like bodies at right angles to their foothold, resembling, when in this position, the surrounding twigs to so great a degree that even the most experienced eye finds some difficulty in detecting them.

It is impossible to believe, however, that they are aware of the advantages of such a position. They can scarcely know, in the first place, that they are surrounded by foes ever upon the watch to attack them. And, even supposing them to be acquainted with that fact, by what process of reasoning do they arrive at the knowledge that by resting in a certain and unusual position they will probably escape the observation of their enemies, while by assuming other attitudes they will be in constant danger of detection? Can they be aware that their bodies resemble so closely the surrounding twigs, and do they infer from this that by stretching themselves out stiff and motionless they may be passed over as inanimate objects? Such a process of reasoning could only be the outcome of intellectual powers of a tolerably high order, and these powers are not apparent even in beings far higher in the scale than are the insects. Is it not far more reasonable to suppose that nature has granted to these and other animals certain means of defence, but that she has gifted them only with the instincts enabling them to use these means in the right manner, and not with the knowledge of the way in which they may be of service?

In almost every wood where game is preserved may be noted one or two "keeper's trees," whereon are suspended the defunct bodies of various cats, weasels, hawks, owls, and other "vermin," which have fallen victims to the guns of the offended gamekeepers.

These carcases are veritable treasure-houses for the entomologist, a few slight blows of a stick sufficing to dislodge hundreds of creatures which had found food and habitation therein, and which come tumbling into his net in a constant stream until he is sometimes almost bewildered by the number and variety of his captures. Amongst these are almost sure to be several burying-beetles, although they are seldom present in numbers equal to those found in carcases lying upon the ground.

I have often wondered whether the burying-beetles found in suspended carrion ever deposit their eggs therein, but am inclined to believe that this is seldom or never the case, and that their sole object in seeking the carcases is to provide themselves with a meal, and not to secure sustenance for their future young.

And this for the following reason. With regard to carcases resting upon the earth the eggs are never laid until the interment has taken place, some instinct appearing to warn the parent insect that such a proceeding might endanger the lives of her future offspring. It is more than probable, therefore, that the same instinct forbids oviposition in carrion which cannot be buried, and which would consequently become unfit for the food of the young long before their development could be completed.

Burying-beetles may often be found, too, in the midst of the common yellow fungus so abundant in woods at the beginning of autumn, evidently enjoying a very satisfactory repast upon the putrefying substance. Such insects, however, like those found in the suspended carcases above mentioned, resort to the fungus simply in search of a meal for themselves, and not of a provision for the next generation, for even if a supply of the food were to be interred, decomposition would be so rapid as to be completed, probably, even before the eggs were hatched.

Now, if we come to reflect, we shall find that the burying-beetles are of service to us in three distinct ways.

In the first place they remove from the surface of the earth putrefying substances which, if allowed to remain, could be productive of nothing but harm. In the next, they convey this putrid matter to the roots of the vegetation, where it is productive of nothing but good. And, thirdly, by means of the burrows which they drive into the soil, they admit another and an equally necessary medium to the roots, namely, the atmosphere.

And this is far more requisite than is generally imagined. One great reason why trees in public thoroughfares so seldom come to any degree of perfection is, that the hard compressed soil with which the roots are surrounded does not allow of the passage of air; and this, together with the more or less complete drought due to the same cause, either kills the trees by slow degrees, or else allows them to assume only a stunted and withered form. If we could only take measures whereby the soil around the roots of these trees should be occasionally loosened, so as to allow of the free passage of air and water, we should seldom have occasion to complain of the ill-success attending our efforts to beautify our streets. In some cases, this precaution has been adopted, and with the very best results. I am well acquainted with one noble avenue of horse chestnuts, where a space of four square feet round the roots of each tree is carefully marked off, and the earth loosened from time to time. The result is that the trees flourish in their fullest perfection, not one solitary example in the entire avenue, a very long one, showing the least signs of weakness or decay.

Of course, I do not mean to infer that the tunnels of the burying-beetles alone can have any appreciable influence upon the growth of vegetation; their numbers are far too small for the results of their labours to be apparent to our eyes. But I do say that their operations are, in conjunction with those of other burrowing creatures, notably the mole and the earthworm, of inestimable service to mankind. Indeed, if those apparently insignificant creatures, the burrowing animals, were to be suddenly annihilated, it is more than probable that we should find our earth reduced, in the course of a few short years at the most, to the condition of a bare and sterile desert, unfit for the habitation, not of man alone, but of any terrestrial creature whatsoever.

# CHAPTER III.

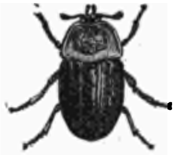
## BURYING-BEETLES AND THEIR KIN.

(*Continued.*)

Assistants of Burying-beetles—Silphas—*Silpha thoracica*, and its appearance—The inmates of an old crab-shell—Larvæ—*Silpha lævigata* and *S. quadripunctata*—Head of Silphas not visible—Mimic Beetles, or *Histeridæ*—Appearance—Habit of simulating death when alarmed—Fore-legs and their uses—Marvellous strength—Cylindrical form of body, and its object—*Hister quadrimaculatus* and its haunts—Ants' nests and their lodgers—Cocktail, or Rove Beetles—Characteristics of group—Method in which the wings are folded—Delicate sense of touch—Anomalous character of nervous system—*Leistotrophus nebulosus*—Its powerful jaws—*Creophilus maxillosus*—*Aleochara fuscipes*, and its telescopic abdomen—Its abundance in carrion—Fetid fluid exuded by rove beetles if alarmed—Cholevas—*Dermestes lardarius*—Larva of ditto—Conclusion.

IN the work of removing putrid substances from the surface of the earth, although not, as a rule, in that of interring them in the soil, the burying-beetles are assisted by a large number of kindred insects, some of the more important of which will be described in this and the following chapters.

Almost always to be found beneath carrion are the curious flat-bodied *Silpha* beetles, of which no less than thirteen species are known to inhabit this country. Of these, much the most striking is the insect known to science as *Silpha thoracica*, but which, in common with by far the greater number of beetles, does not possess a popular title.



*Silpha thoracica.*

This is one of those insects which, when once seen, can never be mistaken, the broad, flat body, and red, crumpled thorax at once separating it from any of its fellows. The wing-cases are traversed by three longitudinal ridges, the second and third of which are connected near the apex by a raised tubercle. This and the ridges together give a peculiarly wrinkled appearance to the elytra, which irresistibly reminds the observer of the skin of a dried raisin.

This Silpha is not so common as many of its congeners, but sometimes turns up in plenty in unexpected situations. I once found it in great numbers in an old crab-shell, which had been thrown upon a rubbish-heap with a few fragments of the flesh still adhering to the interior. Upon taking the shell and turning it upside down on the road the Silphas made their appearance in swarms, together with a host of their larvæ and of other carrion-frequenting beetles, all in a state of woeful alarm at their unexpected dislodgment.

Day after day was the crab-shell tenanted by a fresh set of occupants until not a vestige of flesh was left remaining upon it. By that time, however, a second shell had made its appearance upon the rubbish-heap, and was at once taken possession of in like manner, so that for three or four weeks a constant supply of insects was attracted to the spot.

Curiously enough, the common species of *Silpha*, which are generally to be found in profusion in the carcase of a dead rabbit or similar animal, were decidedly in the minority with regard to these crab-shells, the large and usually scarcer insect being present in the proportion of at least three to one.

Unlike the grubs of the true burying-beetles, whose legs are so small and feeble as to be almost wholly useless for purposes of locomotion, the Silpha larvæ are possessed of considerable activity, and can run almost as rapidly as the perfect beetles. They are flat, broad, black creatures, looking not unlike the large wood-lice so common upon the banks of tidal rivers, and which make off with such speed when the stone which shelters them is suddenly overturned.

Another species of Silpha, *S. lævigata*, differs from the other members of the group as regards the thorax and elytra, which are almost entirely smooth, only the very faintest traces of ridges being visible upon the latter. This insect is wholly black in colour, and averages about half an inch in length.

A third species, *S. quadripunctata*, is of a yellow-brown colour, each wing-case bearing two circular black spots, to which is due the specific name of the insect. This is not so exclusively a carrion-eater as are the other members of the group, and will be again mentioned with regard to another phase of insect work.

In all the Silphas the head is tucked away beneath the thorax, so much so, in fact, as not to be visible without tolerably close inspection. The antennæ are short, but have eleven joints, while those of the *Necrophori* are apparently composed of ten only, the eleventh being so minute as only to be visible upon very careful examination.

In company with the Silphas we are tolerably sure to find a number of small square-bodied beetles, with no perceptible head, and with a peculiarly glossy appearance about the wing-cases. These are Mimic Beetles (*Hister*), so called from their habit of simulating death when alarmed in any way, and remaining motionless until they imagine the danger to be over.

*Hister rugosus.*

These little beetles are well worthy of a close examination, their structure being remarkably curious and interesting.

In general appearance they are not unlike square glass beads, and, indeed, when simulating death, throw off so completely the signs of animation that they would certainly escape recognition as living beings by any but an experienced naturalist. The head, at such times, is packed neatly away beneath the projecting thorax, the legs are drawn up closely to the body, and the insect lies inert and seemingly lifeless until such time as it considers itself once more in safety.

This peculiar habit is common to many other insects, which, being neither swift of wing nor speedy of foot, would stand but a poor chance of escape from their many foes were they not provided with some special means of protection. And this custom of feigning death is far more effective than would at first seem to be the case, for not only are the insectivorous birds, &c., less likely to detect a motionless than a moving insect, but, as they feed upon living prey only, would be tolerably certain to pass it by even were they to penetrate the secret of its disguise.

The wing-cases are considerably shorter than the abdomen, the two terminal segments of which are left completely unprotected. Notwithstanding the small size of their coverings, however, the wings themselves are extremely large and broad, and are carefully packed away, when not in use, in a manner which must be seen to be appreciated.

As is the case with almost all burrowing insects, the fore-legs, which are those principally used for digging purposes, are short, broad, and exceedingly powerful, the first segment of the thorax being of great comparative size in order to supply space for the requisite muscles. The foot itself, which is employed only in locomotion, is small and insignificant, and, when not in use, is folded into a groove provided for that purpose in the tibia, in order that it may not interfere with the movements of the limb. The tibia itself, which is widest at the extremity, is armed with a number of strong horny teeth, which serve to scratch up the soil, while the broad edge of the limb itself acts as a shovel, and removes the loosened earth whenever necessary.

The strength of these legs is simply astonishing, and may easily be proved by attempting to imprison a mimic beetle in the closed hand. No matter how tightly it may be held, the insect is sure before many minutes have passed to force its way between the fingers, the powerful digging legs being the principal agents in the escape, and producing, by means of the sharp teeth with which they are armed, divers unpleasant results upon the skin of the captor.

In the *Necrophori* and *Silphidæ* before described the fore-legs are not endowed with any special powers, the former insects performing all their digging operations by means of their shovel-like heads, while the latter burrow little or not at all. In the mimic beetles, however, these limbs reach their full development, their muscular strength being as far in excess of that of the remainder of the body as would be the case if the arms of a powerful man could be annexed to the body of a child of a few months old.

We find a parallel instance of this extraordinary development in the case of the mole, which we may take as a type of burrowing animals ; and it is worthy of notice that the digging limbs of the mammal and of the insects, widely apart though their respective owners may be in the scale of nature, are yet constructed upon precisely the same principles, and in an almost exactly similar manner, uniting in themselves the properties of both the pick-axe and the shovel.

In every case where a body is intended to pass through any resisting medium we find that a cylindrical form is that best adapted for enabling it to do so with the least possible difficulty. This principle we carry out in many of our inventions: such, for instance, as our boring tools, which are intended to work their way through wood, stone, or metal; our projectiles, which are to pass through the air; and the newly-invented "Fish" torpedo, which is to traverse the water. All these depend for their utility upon their form, which, however, has only been copied from nature. We find the same cylindrical shape in the various creatures which burrow into the earth, in the fish which pass through the water, and also in the bodies of the birds which traverse the air, subject always to such slight modifications as may be serviceable to any individual species.

Nor do the little mimic beetles form any exception to the rule, for their smooth, polished, cylindrical bodies pass through the soil with only the slightest possible resistance. The shortness of the limbs, too, prevents them from hindering the passage of their owner, so that the whole structure is essentially that of a burrowing creature.

Of mimic beetles belonging to the typical genus (*Hister*) no less than fifteen species are known to inhabit Great Britain, several of these, however, being only occasionally met with. With one or two exceptions they are all very similar in appearance, the colour being an uniform jetty black, while the chief points of distinction are to be found in the dotted lines which adorn the wing-cases, and which vary considerably in the different species. The number of teeth upon the tibiæ of the fore-legs, too, and the punctuation of the two unprotected terminal segments of the abdomen, have also to be taken into account.

One or two of these insects, however, are rather more gaily ornamented than the rest of their kind, each wing-case being adorned with either one or two spots, or rather blotches, of brilliant red. Such, for instance, is the large four-spotted mimic beetle (*Hister quadrimaculatus*), which is generally found in the neighbourhood of tidal rivers. This, the largest insect of the group, is nearly half-an-inch in total length.

Besides these true mimic beetles, if we may so call them, there are many allied species belonging to the same group, but which, on account of various slight differences in point of structure, have been separated into different genera. In work and habits, however, they are all very similar, preying, both as grubs and as perfect insects, upon putrefying matter, and sharing the task of its removal with the many other insects which we may collectively designate as nature's scavengers.

One of these insects, however, deserves a word of mention for the curious manner in which it departs from the habits of the other members of the group, for it takes up its abode in ants' nests, where, curiously enough, it seems to be protected and even cherished by the inmates, who carry it away into the inmost recesses of the nest at the first sign of danger. Why this should be the case no one has yet been able to ascertain, and we can only conjecture that the presence of this, and also of other myrmecophilous beetles, as they are called, in the nests must be in some way beneficial or agreeable to the ants.

This particular species, which is by no means a common insect, is known by the rather lengthy scientific title of *Hetærius sesquicornis*, and is of an uniform yellowish-brown colour. It is quite a small insect, never exceeding one-eighth of an inch in length.

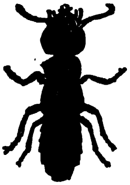
With this and one or two other unimportant exceptions, the beetles of this family are all frequenters of decaying substances, where, from early spring to late autumn, both the grubs and the perfect insects are to be found. The latter are long whitish creatures, with forked tails, and are about as different in appearance from the perfect insect as could well be the case.

With regard to the life-history of these, and of most of the carrion-feeding beetles, but very little is, and probably ever will be, known. For, owing to the nature of their food, and their darkness-loving character, it is almost impossible to watch their habits even in captivity, while in a state of freedom it is manifestly out of the question.

BESIDES the burying-beetles, silphas, and mimic beetles, there are sure to be in every piece of carrion a number of Cocktail, or Rove Beetles, varying in length from about one-sixteenth to five-sixths of an inch in length. These are far too numerous to be separately described, and we must therefore content ourselves with the examination of one or two species only as representatives of the whole.

In the first place, a few words will be required concerning the family to which these beetles belong. Scientifically, the group is known by the title of *Brachelytra*, i.e., shortened "elytra," an appellation due to the curiously abbreviated nature of the wing-cases, which generally leave either six or seven of the abdominal segments entirely unprotected. Notwithstanding the extremely small size of their coverings, however, the wings are remarkably large and broad, and are folded and spread with the most astonishing rapidity, many of the species taking to wing with the activity of a blue-bottle.

The manner in which these broad and ample wings are packed away beneath their miniature cases is most remarkable, the operation being conducted chiefly by the extremity of the long and flexible abdomen, which is doubled backwards over itself for that purpose, and performs its task with most surprising neatness and accuracy. It is from the curious position adopted during this operation, and assumed also when the insect is in any way alarmed, that the members of this group of beetles have earned the popular title of "cocktails."



Cocktail-beetle (*Staphylinus*).

In order to perform its duties in so perfect a manner, the extremity of the abdomen must necessarily be endowed with a most delicate sense of touch, although the nerves supplying it cannot be detected by the most searching examination, for the insect, with its seemingly inadequate qualifications, is able to perform in two or three seconds a task which a skilful human operator, armed with the most delicate instruments, could not complete in as many hours. And what renders the feat the more extraordinary is the seeming ease with which the entire operation is conducted, the wings being first loosely shaken into folds, and then smoothed and packed away beneath the elytra by the aid of two or three movements of the flexible abdomen.

It cannot but be considered a most extraordinary fact that the insect should be gifted with so wonderfully keen a sense of touch, while the sensation of pain seems to be almost wholly wanting. With ourselves we find exactly the reverse to be the case, those parts of our bodies, such as the tips of the fingers, which are most highly endowed with the sense of touch, being also the most sensitive to pain.

Insects, however, are differently constituted, and the same beetle which can fold its wings and pack them away beneath their cases simply by the aid of the wonderfully developed nerves in the hinder segments of the abdomen will yet endure the most frighful mutilations with seeming indifference. Thus, cases have been frequently recorded in which insects, after having been deprived through some accident of their abdomens, have yet continued to feed without loss of appetite, although, like Baron Munchausen's horse, they lacked stomachs in which to digest their meal. Other insects, again, have been known to live for some considerable time after decapitation, the peculiar nature of the nervous system seeming to divide the life-principle into a number of centres, each of which must be separately destroyed before the vital essence is extinguished, instead of concentrating it into one, as in the higher animals.

From these, and many other observations of a like nature, it would seem, in spite of Shakespeare's testimony to the contrary, that the sense of pain, as we understand the word, is almost wholly wanting in insects, although that of touch is present in a very high degree. This, however, seems to be the case with certain portions of the body only, other parts appearing quite callous in comparison.

The common earwig folds its wings in a manner very similar to that adopted by the cocktail beetles, the forceps with which the extremity of the abdomen is furnished, however, giving it a considerable advantage over those insects.

In nearly all the cocktails the body is very long in proportion to its width, in some cases to so great a degree that the insect appears absolutely threadlike. The antennæ, too, are seldom thickened, and the suture, or line of junction of the elytra, is invariably straight.

Having now described the general characteristics of these insects as a group, we will proceed to examine the individual peculiarities of one or two typical species.

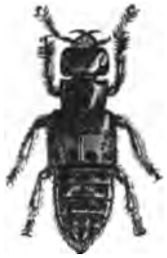
The first of these shall be the very handsome beetle scientifically known as *Leistotrophus nebulosus*, but which, like so many other insects, possesses no popular title. This is a remarkably beautiful insect, in spite of the sombre nature of its colouring, which consists of nothing more than one or two shades of brown mottled with velvety black. Its sober hues notwithstanding, it is a far prettier beetle than many of its more gaily-clad relatives, the quiet harmony of its tints being fully as pleasing to the eye as the gaudy colours which adorn other members of the same group.

The insect is a tolerably large one, being about three quarters of an inch in length, and is plentiful from spring to autumn wherever carrion is to be found. It is a remarkably active being, taking to wing at the least alarm, so that a quick snatch is requisite in order to capture the creature if it be required for close examination. This operation, however, must be conducted with care, for the beetle is possessed, not only of large and powerful jaws, but also of the knowledge as to the most effective way of using them.

I well remember, when I first met with the insect, that I incautiously held it prisoner between my finger and thumb, and was rewarded by feeling its long, sickle-like jaws meet in my flesh, the captive having twisted itself round and inflicted its bite almost before I had fairly seized it.

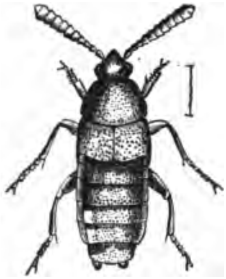
The Leistotrophus is not confined to carrion, but may often be seen in rubbish-heaps and similar localities; and I once found it in numbers in a heap of semi-rotten mangolds which had been piled up in a field in order to serve as food for cattle.

Another species, closely allied to the preceding, is the insect known as *Creophilus maxillosus*, which may be at once recognised by the broad band of long grey hairs which crosses the wing-cases, the central segments of the abdomen being mottled at the base with similar pubescence. This is also a very common species.


*Creophilus maxillosus.*

Another very abundant insect, especially in carrion suspended from the keepers' trees, &c., is a smaller beetle bearing the title of *Aleochara fuscipes*, which belongs to a group whose members are characterised by the short antennæ, the broad, flattened body, and the manner in which the head is sunk into the thorax. The abdominal segments possess the "telescopic" faculty in an even greater degree than is generally the case with brachelytra, the insect shrinking immediately after death to about one half of its former proportions.

This is a rather soberly-coloured insect, the whole of the body being black with the exception of the wing-cases and the legs, which are of a dull reddish-brown hue. It is quite a small species, never exceeding a quarter of an inch in length.



*Aleochara fuscipes.*

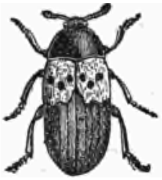
This beetle is one of the most abundant of all the carrion-haunting brachelytra, fifty specimens or more often issuing from a single suspended carcase. If a net be held beneath, in order to catch the beetles as they fall to the ground, a most curious sight is presented, the frightened insects rushing excitedly in all directions, and tumbling over one another in their eagerness to escape.

Just as is the case with the burying-beetles and Silphas, these cocktails possess the power of exuding at will a fluid of a remarkably fetid odour, which is due, in all probability, to the nature of the substances upon which these insects feed.

It is this fluid which gives rise, in great measure, to the irritation caused by one of these insects when it happens to get into the eye, for, alarmed by its novel position, the beetle instinctively raises its tail, exuding at the same time a drop of the liquid secretion from the mouth. Three out of four of the so-called "flies" which find their way into the eye belong to this group of beetles, as may be easily proved by even a cursory examination after they have been removed from their disagreeable position.

Reluctantly passing from this interesting group of beetles, which comprises more than seven hundred and fifty species in Great Britain alone, we must devote a few words to the small group included in the genus *Choleva*, the members of which ably supplement the labours of the foregoing insects in their useful work. They are all of small size, the largest never reaching a quarter of an inch in length, and may be known by their narrow bodies, their oval wing-cases, and their long and slender legs and antennæ. They are not burrowing insects, like the mimic beetles, for their development during the earlier stages of their existence is so rapid that the storage of food beneath the surface of the ground is rendered unnecessary; but they nevertheless do good service in the removal of putrid matter, both larvæ and perfect insects finding their subsistence in decaying substances.

All the beetles hitherto described make their attacks upon carrion while it is yet comparatively fresh and soft, but we now come to a group whose energies are directed towards the removal of the carcases which have been indurated by the sun, and thus hardened to so great a degree that the jaws of the ordinary carrion-feeders can make no impression upon them. A very well-known member of this group is the Bacon Beetle (*Dermestes lardarius*), which, useful as it is in its proper place, is rather apt to enter houses and wreak havoc therein upon any furs or skins with which it may happen to meet. Natural history collections, too, often suffer greatly from its attacks, and many a valuable specimen has fallen a victim to the jaws of this destructive little beetle, whose presence is generally notified by the appearance beneath the specimens attacked of the cast skins of the larvæ, together with the "frass" which is the result of their labours. When such signs are visible, the only chance of saving the collection lies in the total destruction of every specimen of the insect, for, if a single example be allowed to remain, the whole work will shortly have to be commenced afresh.



*Dermestes lardarius* (magnified).

Even arsenical soap, deadly as it is, seems to have but little power of deterring the Dermestes, which passes by the poisoned skin, and attacks only the fur or feathers, as the case may be. These, however, it utterly destroys, stripping them from the body in large patches, and completely ruining the appearance of the specimen.

It would seem that in some cases these beetles depart from their usual habits and do not wait for the death of their victim, for Moses Harris, the old entomologist, tells us that he has found specimens of *Dermestes* within the body of a living eyed hawk-moth.

Taking into consideration its destructive habits when it happens to make its way into our houses, we must consider the Dermestes as one of those insects which are partly friends and partly foes, its services, however, fully compensating for any trifling damage which it may inflict upon our belongings.

Although by no means brightly coloured, the bacon beetle is rather a handsome insect, the head, thorax, and wing-cases being black, while a broad band of yellowish-grey hairs, marked with six black spots, crosses the latter and occupies almost the whole of the basal half. Upon close examination it will be seen that the black spots in question are caused by the absence of hair, so that the colour of the elytra is rendered visible.

As is generally the case with insects, the bacon beetle performs the greater part of its work while in the larval condition, the labours of the imago being of comparatively little importance. And the reason of this is not far to seek, for while the perfect insect has only its present requirements to satisfy, the grub has to provide for its future development, as well as to lay up a store of nutriment upon which to subsist while it lies inert and helpless in the pupal condition. Thus an insect, during the larval stage of its existence, will often consume many times its own weight of food in the course of a single day: while, when it has attained to its perfect condition, it requires very little nourishment, and in some cases spends the remainder of its life without the necessity for taking food at all.

Larva of *Dermestes* (magnified).

We have now glanced, although but hastily and imperfectly, at some few of the beetles which serve us by performing the duties of scavengers, and removing from the surface of the earth putrid substances which, if allowed to remain, would, by the noxious gases emitted during their decomposition, certainly be productive of incessant fevers and agues. In the following chapters I shall attempt to show that these beetles share their task with many assistants, that earth and water alike are cleansed and purified by their agency, and that to these apparently insignificant beings we owe far more than we might have deemed possible.

## CHAPTER IV.

### THE BLOW-FLY AND THE FLESH-FLY.

The Blue-bottle, or Blow-fly—Generally detested, yet most serviceable to man—Troublesome in some ways, but invaluable in others—Life-history—Larva never changes skin—Curious mode of assuming pupal form—Influence of temperature on development—Method in which imago emerges from pupal shell—Modification of hinder-wings into "balancers"—Structure of foot—Flesh-fly—Mode of reproduction—Linnæus on the Flesh-fly—Summary.

THE introduction of a creature so universally detested as the common Blue-bottle, or Blow-fly, into the ranks of our insect benefactors will probably give rise to a sensation of considerable astonishment.

We have so long been accustomed to consider it as one of our worst foes, and to destroy it whenever practicable, that, when close and careful investigators into its habits tell us that we have misunderstood the insect, and have persecuted a benefactor instead of an enemy, it is scarcely surprising if we look upon the statement with incredulity, or even with positive disbelief. But a very little reflection will show us that the new light in which the insect is regarded is undoubtedly the right one, and that the blow-fly is one of those multitudinous creatures which, although in reality of the very highest service to us, have hitherto failed to meet with the appreciation which they deserve.

It is true enough that in certain ways it is a troublesome, and even a destructive insect.

For instance, it does not incur our favourable notice when it enters our sitting-rooms and flies excitedly round our heads with the noisy and aggressive hum which leaves us no hope of quiet until we have expelled the intruder. Neither can we defend its proceedings when it makes its way into our larders, and deposits its eggs upon the meat contained therein, in its efforts to provide sustenance for the forthcoming generation.

But these trifling annoyances count for very little when we take into consideration the vast utility of the insect in other ways, for, with the exception, perhaps, of the burying-beetles themselves, there is no insect which bears so considerable a share in the removal of carrion from the surface of the ground, and which, therefore, deserves a higher place in our esteem. Unfortunately, however, the prejudice which exists against the insect, and for which there are certainly good grounds, prevents many of us from looking at matters in the same light, and we allow the bad qualities of the insect to blind us to those which afford far more than sufficient compensation for them.

The life-history of the blow-fly is of a singularly interesting nature, for in two points at least it differs from that of almost all other insects.

The first of these relates to the larval, or grub stage of development. As is well known, the larvæ of almost all insects grow with such rapidity that after a short time has elapsed the skin, already stretched to its utmost capacity, can no longer contain the fast-increasing body. It therefore splits along the back, and the grub slowly crawls out of its late garment, clad in new and generally more brightly-coloured apparel. So completely does the insect change its coat that even the membranes which line the stomach and the innumerable tracheæ, or breathing-tubes, are cast at the same time with the outer skin.

This process is repeated several times during the life of the caterpillar, from three to seven changes of raiment being usually made.

But the grub of the blow-fly, curiously enough, is embarrassed by no such necessity, its skin seeming to be endowed with greater elasticity than is usually the case, for throughout its existence no change of garment is required. And, more extraordinary still, the skin is not thrown off when the insect enters upon the pupal stage of its existence, but merely hardens, forming a cocoon, so to speak, in which the pupa lies enclosed.

These two facts alone would be amply sufficient to render the life-history of the blow-fly remarkable, but we have other points of almost equal interest in the strangely variable time required for the full development of the insect from the egg to the imago, and in the manner in which the perfect insect makes its way out of the pupal shell.

As seems to be the case with all insects, and, indeed, with animated beings in general, heat serves to accelerate and cold to retard development. Thus, in the heat of summer, the fly passes through the three introductory stages of its growth—namely, the egg, the grub or larva, and the pupa, in the course of a few days, and the perfect insects often emerge in time to provide for a second generation upon the same carcase on which they themselves fed as larvæ.

In the spring and autumn this period is considerably lengthened, and we are told by Mr. B. T. Lowne, who has devoted special attention to the insect, that the development is altogether checked should the temperature fall below 45° Fahr. So, during the winter months, the larvæ and the pupæ of the fly remain unaltered, passing into a state of hibernation, or torpor, in which respiration ceases, and the vital functions are reduced to the lowest degree compatible with the preservation of life. The first warm day, however, arouses them from their slumber, and should the alteration in the temperature continue, the perfect insects appear in a very short time.

It is owing to this curiously-powerful influence exercised by a reduced temperature that the grubs of the blow-fly are preserved in order to serve as bait for anglers, the "gentles," as they are called in angling parlance, being buried in cold cellars, where they live for many months without completing their growth.

The change to the pupal condition takes place beneath the surface of the earth, into which the grub burrows as soon as it feels the first signs of its impending transformation. For some little time it lies motionless, and apparently unaltered, the actual change in form and character taking place with startling suddenness, and occupying altogether little more than five or six minutes.

The interior of the insect appears to undergo as complete a metamorphosis as the outer form. To quote the words of Mr. Rymer Jones:—

"The included mass"—when examined some twenty-four hours after the transformation has taken place—"presents not the slightest appearance of an insect; it has neither legs, wings, nor head; it seems to consist altogether of a creamy fluid, the consistence of which is just sufficient to make its particles cohere, so as to form an elongated, oval mass."

By slow degrees, however, this mass loses its semiliquid consistency, and the various organs of the future imago begin to make their appearance, the time required for their full development varying, of course, according to the season of the year.

When at last the perfect insect is fully ready to make its appearance in the world, it forces off the anterior extremity of the pupal shell by means of a curious organ, if we may so call it, with which the head is furnished, and which is known by the title of the "frontal sac."

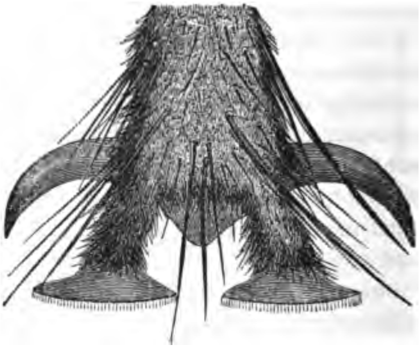
This consists of a protuberance upon the upper part of the head, immediately above the antennæ, which is formed of a membrane expansible at the will of the insect, and possessed, apparently, of considerable muscular power. When fully inflated this curious organ exceeds in size the head itself, into which, however, it is almost entirely absorbed when the insect has made its escape from the pupa, and has therefore no further need of its functions. Mr. Lowne tells us that this sac is also connected with the olfactory system, and with the humming sound produced by the insect during flight. The former of these two statements, however, he seems to base upon no decided evidence, and I cannot but doubt whether the sac really performs the functions which he attributes to it.

The blow-fly is also worthy of examination when it has completed its growth, and arrived at the perfect stage of its existence.

It will be quickly seen that two wings only spring from the thorax, whereas insects are in general provided with four of these organs. In place of the lower pair, however, will be seen two curious little objects, looking like small knobs placed at the extremity of short footstalks. These are, in reality, the lower wings in a modified form, and are called "halteres," or balancers, from the important influence which they exercise upon the equilibrium of the body during flight. Notwithstanding their small size, they seem to be indispensable adjuncts to the locomotion of the insect, for if they be damaged or removed their owner can no longer direct its course, but falls helplessly to the ground, from which it is unable again to rise.

At the base of the wings themselves may be seen a pair of small wing-like appendages, called "alulets," the use of which has not as yet been ascertained.

Another point worthy of particular attention is the manner in which the fly retains its foothold when walking upon a perpendicular, or even an inverted surface. This power is generally supposed to be due to the exhaustion of air beneath the foot-pads, but that this is not the case may be easily proved by examining the foot with a tolerably high power of the microscope. The observer will at once notice that it is not provided with suckers, such as are found upon the feet of various water-beetles, and by means of which the air could be exhausted, but that it secretes



Foot of the Blow-fly (highly magnified).

a glutinous fluid which ensures a firm foothold in any attitude the insect may assume.

It may reasonably be asked how it is that the fly should be able to detach its feet from the surface to which they adhere, for it would seem that a fluid sufficiently viscous to enable the insect to resist the attraction of gravity would necessarily tend to hamper, if not altogether to prevent, its movements. This difficulty, however insuperable as it may appear, is overcome in a very simple manner, the feet being lifted obliquely from their hold, so that the adhesive nature of the fluid is almost wholly neutralized.

A very simple illustration of this fact may be found by attempting to lift a postage-stamp from an envelope before the gum has been allowed to harden. It will be found that no amount of direct force will suffice to bring about the desired result, but that, if a corner be raised and the stamp lifted in an oblique direction, the difficulty will at once disappear.

An allied species of Fly, namely, the Flesh-Fly (*Musca carnaria*) is, owing to a peculiarity in its life-history, of even greater service than the preceding, for the parent insect, instead of placing eggs upon the carrion which is to form the food of her future offspring, deposits living larvæ, which immediately set to work upon the great business of their lives. The development is thus considerably accelerated, and a second and third brood of the fly make their appearance in a wonderfully short space of time.

Upon opening the body of a female flesh-fly the young grubs will be found lying side by side in two long riband-like rolls, and as each of these contains from eight to ten thousand larvæ it will be seen that the influence of even a single fly is very considerable. The famous naturalist, Linnæus, indeed, was so impressed with the prolific nature of the insect and the work which it performs, as to aver that three of these flies would devour the carcase of an ox as soon as could a lion; and this statement is, if anything, rather below than above the mark.

Flesh-fly (magnified).

For Linnæus forgot to take into consideration two important points, the first being that the lion eats only once in a day, spending most of the remaining time in sleep, whereas the flesh-fly grubs feed without cessation, and would therefore naturally gain upon the lion during his hours of slumber. And the amount of food which they would consume would be very considerable, for as each fly would deposit, upon the lowest computation, sixteen thousand larvæ, we should have a total of nearly fifty thousand grubs feeding continuously day and night, each of which would consume many times its own weight of flesh in the course of every twenty-four hours.

The second point relates to the difference in climate between our own land and the tropical regions which are the chosen dwelling-places of the larger carnivora. As has previously been stated, a high temperature serves to accelerate insect development, so that in equatorial lands the fly would pass through its transformations in far less time than would be occupied in colder regions. So, in a very short space of time, the first brood of grubs would make their appearance as perfect flies. These would deposit their young in vast numbers upon the remnants of the carcase, and they, in a few hours, would probably leave little but the skin and bones remaining. Indeed, it is very doubtful whether this second generation would be provided with sufficient sustenance to enable them to complete their development.

Taking these two points into consideration, therefore, we may, I think, fairly conclude that under similar conditions, the three flesh-flies would devour the ox in far less time than would be occupied by the most ravenous lion which ever manifested a taste for beef.

Of all the insects which prey upon carrion the flesh-fly is usually the first to detect the presence of its food, the very slightest signs of incipient decomposition being apparent to its sensitive olfactory organs. To so great an extent is this the case that it is almost impossible to find the body of a bird or small animal, no matter how recently dead, upon which the flesh-fly has not deposited its larvæ, the insect generally placing them at the base of the limbs, or upon the surface of the body next the ground, in order to conceal them from the eyes of the multitudinous parasites which are ever on the look-out for victims.

Although the greater part of the work of these two flies is performed while they are yet in the larval stage of their existence, the perfect insects are of service to a certain extent, although the structure of the mouth, in which the jaws are replaced by a proboscis, precludes them from feeding upon the solid portions of the carrion.

Both the blow-fly and the flesh-fly are members of the same division of the Diptera, or two-winged flies, namely, the *Muscidæ*, a group comprising in this country alone more than one thousand species. Little as we yet know of the life-history of many of these, it is still certain that a large proportion are carrion-feeders, and as such are undoubtedly entitled to a place in the ranks of our insect friends, although, owing to the prejudice which exists against them, it may yet be many a long year before they obtain the appreciation which they deserve.

We have now arrived at the end of the first branch of our subject, and have seen, although very imperfectly, how much we owe to insects in the first department of their work.

From the moment in which the principle of life is extinguished in any animal to that in which the last particle of flesh is removed from its bones it is ceaselessly attacked by numberless insects, which, in both their larval and perfect stages of existence, devote themselves to the task of removing the carcase from the surface of the earth with the least possible delay. And we shall find, in the ensuing chapters, that the labours of these insect scavengers are not confined to the removal of carrion alone, but that the destruction of decaying matter of all kinds falls equally under their province.

We shall also find, that, great as are the services which insects thus render to us, their operations in this respect form but one of the departments of the wonderful work which these little creatures are incessantly carrying on in our behalf.

# CHAPTER V.

## DOR-BEETLES AND THEIR WORK.

**Mission of Dor-beetles—Method in which work is performed—Power and form of digging-legs—Depth of burrows—Comparison between man and beetle—Different kinds of Dor-beetles—*Typhæus* and its horns—*Geotrupes stercorarius*—"Shard-borne Beetle" of the poet—Distinctions between species of *Geotrupes*—*G. vernalis*—*Aphodii*—Their abundance—*Aphodius fossor*—Cercyons—Similarity in structure in all dung-feeding beetles—Variability of Cercyons—Cock-tails again—*Philonthi*—Dung-feeding Flies—*Scatophaga stercoraria*—Curious form of egg—Summary.**

We now come to a group of insects which in many points bear a close resemblance to the burying-beetles already described, for, as is the case with those insects, their mission lies in the removal of decaying animal matter from the surface of the earth, and its deposition beneath the soil. The chief difference between the two groups lies in the nature of the food selected, for, whereas the burying-beetles feed almost wholly upon carrion, the members of the group we are now about to describe direct their attacks upon the droppings of animals.

These beetles are popularly known as Dor-beetles, Dumble-dors, or Watchmen, and scientifically as *Geotrupidæ*, a very appropriate title, signifying "diggers in the earth." They are all common insects, and may be noticed on any warm evening in spring or summer, circling round and round with the loud drowsy hum which is one of their principal characteristics. At such times they are engaged in searching for food, and before very long are sure to fly off in some direction in which their delicate olfactory organs have detected the presence of the wished-for substance. This found, they at once set to work upon their appointed task, which, however, they perform in a very different manner from that employed by the burying-beetles. For, they make no attempt to bury the whole mass, but inter only a sufficient quantity to serve as food for their future offspring during the first week or two of their existence. Neither is this limited amount placed in a single grave, but is deposited in a succession of burrows, each sufficiently large only to allow of the free passage of the insect. These tunnels are hollowed out by means of the fore-legs, into which almost the whole strength of the body seems to be concentrated. These digging limbs bear a very close general resemblance to those of the mimic beetles already described, being furnished with a number of strong horny teeth, which serve to scrape away the earth, while the broad, flat edge of the tibia acts as a shovel in removing the loosened soil. The foot, however, does not fit into a groove when not in use, but lies back against the limb, in order that it may not hamper the movements of the insect.

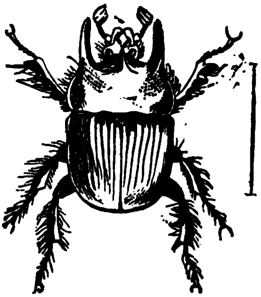
As a general rule, the tunnels of the dor-beetles run perpendicularly for about ten or twelve inches into the soil, a truly wonderful distance when we consider with what seemingly inadequate tools the insect is provided. We cannot imagine a man digging a well some seventy feet deep merely by the aid of his hands and feet, much less repeating the process some ten or a dozen times with scarcely an interval of repose. And yet, allowing for the discrepancy in size between the two beings, this is precisely what is done by the dor-beetle, whose burrowing powers are simply marvellous if its small dimensions are taken into account.

In each of these burrows the beetle deposits a small quantity of dung, in the centre of which is placed a single egg. Thus the young grub, on making its appearance in the world, finds itself provided with nourishment for a week or so, at the end of which time it is able to make its way to the mouth of the burrow and cater for itself.

During warm, dry weather the dor-beetles are seldom to be seen, for the hardened ground resists even their wonderful digging capabilities. As soon as the first shower moistens the soil, however, they appear as if by magic, and pasture fields at such times often appear literally riddled with their tunnels.

It is a curious fact that the dor-beetle seems never to be soiled by contact with the repulsive substances through which it is constantly burrowing, emerging from its tunnels as clean as when it entered. Its polished body, however, seems to afford it no protection from the adhesive powers of clay, and after excavating in a soil of that nature the beetle is often so encrusted with the tenacious substance that it can scarcely be recognized.

Seven species of dor-beetles are known to inhabit this country, our first example of which shall be the extraordinary insect known as *Geotrupes Typhæus*, which calls to mind some of the curious forms assumed by beetles in tropical lands, and which is so different in appearance from the remaining members of the group, that until lately it was placed in a genus by itself, under the title of *Typhæus vulgaris*.



*Geotrupes Typhæus.*

Its chief claims to distinction lie in the remarkable manner in which the thorax is developed into three long horns, two of which spring from the anterior angles, enclosing the head between them, while the third, which slants obliquely upwards, is placed midway between the outer pair. This strange armature invests the insect with a peculiarly ferocious appearance, which, however, greatly belies its real character, for it is as harmless a creature as can well be imagined, and has no idea of utilizing its thoracic horns as weapons of offence.

The female insect is not furnished with these curious organs, which are represented merely by three rudimentary projections. Even in the male they are exceedingly variable in size, sometimes projecting in front of the head itself, while in other cases they are almost as insignificant in dimensions as are those of the female beetle.

The Typhæus is a tolerably common insect, although it is not very often seen, excepting by those who know how to look for it. It appears twice in the year, in May and August.

A still more abundant species is *Geotrupes stercorarius*, the "shard-borne beetle" of Shakespeare, which may be known from its congeners by the fact that the whole of the upper surface of the thorax is visibly, though finely, punctured, and that there are seven grooves, or *striæ*, running longitudinally upon either wing-case between the suture and the prominence at the shoulder. Indeed, it is principally by these two characteristics, namely, the punctuation of the thorax and the striation of the elytra, that the various species of *Geotrupes* are separated, for most of the insects belonging to the genus are so similar in general appearance that they cannot be distinguished without close examination. And, moreover, they are so variable in colouring, and in certain other points, that it is only by such slight, but unchanging, structural features that any definite points of distinction can be settled upon. For instance, it would be by no means unusual to find three examples of this species in company, in one of which the lower parts of the body should be of a rich violet hue, while the same parts should be steel-blue in the second, and brilliant metallic green in the third. This variability, too, extends also to size, some specimens being at least a third as large again as others, no inconsiderable difference in an insect measuring, at the most, barely an inch in total length.

Our present species is, perhaps, the largest of the group, being remarkably bulky in proportion to its size. In order to bear so large and weighty an insect through the air, the wings, of course, must be broad and powerful; and this we find to be the case in a remarkable degree. But, nevertheless, the flying powers of the beetle are not of a very high order, for it is not particularly strong upon the wing, and seems, moreover, to have little idea of directing its course, being quite sure to blunder against any obstacle which may come in its way. This want of steering power seems to be common to all the members of the dor tribe, which frequently startle the pedestrian by dashing unexpectedly into his face in the twilight, and inflicting a tolerably smart blow in so doing.

A third species, *G. vernalis*, is plentiful in the early summer months, and may be at once distinguished by its smooth elytra, which only exhibit the very faintest traces of the furrows with which the wing-cases of its fellows are adorned.

WERE the dor-beetles the only dung-feeding insects found in this country, their labours, perhaps, would be of comparatively little service to us, for their numbers would be insufficient for the due removal of the substances upon which they feed. But their operations are supplemented by those of a vast host of other creatures, foremost among which we must place that group of beetles known as the *Aphodiidæ*, comprising, in this country alone, no less than fifty-one species.

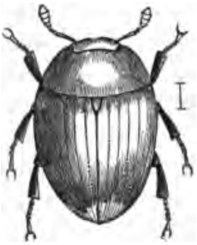
Many of these insects are extremely abundant, and often literally honeycomb the patches of dung with their tunnels, thus not only devouring a considerable proportion of the putrefying substance, but, by admitting the air into the remainder, causing it to dry and harden with such rapidity that but little noxious vapour is given off.

As a type of this group we may take *Aphodius fossor*, the largest of the group, which sometimes attains to the length of nearly half-an-inch. This, a very common species, which appears in early summer, is of an uniform polished black, the wing-cases being ornamented with several distinct striæ. The form of the body, as in all burrowing insects, is cylindrical, the legs being constructed for digging purposes in exactly the same manner as are those of the dor-beetles.

Besides the *Aphodii*, a group of small, globular beetles are found in the same situations, these insects belonging to the genus *Cercyon*, and comprising nearly twenty British species. Although belonging to a totally different family from that in which the dor-beetles are included, it is curious to note how exactly the two insects, the *Cercyon* and the *Geotrupes*, agree in the general features of their structure, both being burrowing species, and both formed upon precisely identical principles.

Owing to their extreme variability, it is by no means easy to ascertain the exact species to which many of these little insects belong. So much is this the case, indeed, that one species of *Cercyon* was described under no less than seven names by the same author. To one or two of the species, however, this rule does not apply, one in particular, *C. unipunctatus*, being easily distinguishable at first sight by the large black spot upon the suture of the yellow elytra, midway between the apex and the base.

It is a curious fact that all the remaining members of the family to which the Cercyons belong are inhabitants of the water, which they leave only occasionally, and for short periods of time. They are not true water-beetles, however, for those insects belong to a totally different group, but are yet inmates of the water, in which the introductory stages of their development are passed, and in which they spend the greater part of their perfect existence.



*Cercyon analis.*

A large number of *Brachelytra*, or "cocktail" beetles, too, render valuable assistance to the many other dung-feeding insects, one large genus, that of the *Philonthi*, or "dung-lovers," deriving its name from the favourite food of the species which it comprises. This is a large and important group, numbering no less than fifty-six British species, many of which are to be found in the greatest abundance in company with the *Aphodii* or *Cercyons*. The most plentiful of these, perhaps, is one of the larger species, known as ***Philonthus æneus***, and this we may take as a type of the rest.

Like most of the cocktail beetles, it is very long in proportion to its width, although it is by no means so thread-like as are many members of the family. In colour it is bronze-black, with the exception of the wing-cases, which are of the peculiar greenish-bronze hue which has earned for the insect the specific title of *æneus*, or "brassy." Upon each side of the disc of the otherwise smooth thorax is a row of four large impressions, while the elytra and abdomen are closely covered with smaller punctures. The total length of the insect is about half-an-inch.

PASSING by many other dung-feeding beetles without mention, we must devote a few lines to an insect belonging to a different order, viz., the Diptera, or two-winged flies, which is of considerable value in the removal of putrid substances. This is the well-known Dung-fly (*Scatophaga stercoraria*), which is generally to be seen in numbers settling upon the surface of every patch of fresh cow-dung.

This fly is almost invariably the first to attack the dung, and generally precedes the dor-beetle and its allies by many hours, these latter insects seldom beginning operations until their food has become partially dried and hardened by the sun. The reason for this promptitude is found in the requirements of the egg, which shrivels and perishes unless it be kept constantly moist. So, the parent insect avails herself always of the freshest procurable dung, in order that the requisite condition may be fulfilled,

Air seems equally necessary for the proper development of the egg, which is formed in a very singular manner to prevent it from sinking entirely into the semi-liquid substance, and thus becoming deprived of the benefit of the atmosphere. Shaped somewhat like the egg of a bird, one end being larger than the other, two horn-like appendages spring from the broader end, and at once diverge from one another, their bases being situated about one-third of the length of the egg from the upper part. These horns, if we may so term them, effectually bring about the desired result, for they invariably keep one-third or so of the egg projecting above the surface of the dung, and so allow of the necessary contact with the atmosphere. There is a curious analogy between these eggs and those of the Water-Scorpion and the Ranatra, which are fringed with a series of horny

*Scatophaga stercoraria.*

hooks, enabling them to retain their position in the holes perforated by the parent insect for their reception in the leaves of various aquatic plants.

The grub proceeding from these curious eggs is remarkable chiefly for its form, the body being conical in shape, and the tail end considerably larger than the head. The perfect insect, with its yellow body, and its clothing of stiff hairs, is too well-known to require a detailed description.

WITH this fly concludes our account of the insect scavengers of the land, a group of beings upon which our sanitary welfare greatly depends. No putrefying substance can escape their detection for very long; none can resist their combined attacks. And, be it animal or vegetable matter, in large or small quantities, it is sure in the course of a very short time to disappear from the surface of the earth, some to act as manure beneath the soil, and the rest to serve as nourishment for the forthcoming generation of the insects which have caused its removal. In the succeeding chapter, we shall see that the water is as well provided with scavengers as the land, and that, but for their efforts, there is scarcely a pond or pool in the country which would not shortly become a stagnant mass of corruption, dangerous to the health, and even the life, of the human race.

# CHAPTER VI.

## SCAVENGERS OF THE WATER.

How ponds are purified—Water-scavengers—Water-beetles and their structure—Fish-like form—How a water-beetle swims —"Feathering"—Paddles used by North American Indians —Method of breathing, and its object—Air-reservoir—Position of spiracles, or breathing-holes—Power of remaining submerged for lengthened periods—Broad and powerful wings—Mode of taking to flight—How water-beetles regain the water—A curious mistake—Awkwardness of water-beetles upon dry land—Life-history—Larvæ, and their predacious nature—Structure of jaws—Mode of capturing prey—Respiratory apparatus—Pupal existence—*Dyticus*, or Great Water-beetle—Size and appearance—Gizzard of *Dyticus*—Difference between sexes—Structure of anterior feet of male —Prolonged existence of the Dyticus.

Do we ever ask ourselves what becomes of the innumerable beings which daily perish in our pools and ponds?

A vast number, of course, are slain, only to be devoured by creatures more powerful than themselves; but a large proportion, nevertheless, must die from other causes. What becomes, for example, of the myriads of small beings which are drowned in every flood; which are washed by the rain from the retreats in which they have sought refuge; which every wind blows by thousands into the water? They cannot exist for very long, for there are few creatures not specially designed for an aquatic life which can resist the influence of the liquid element for any length of time; and, if they were to perish, and to remain to putrefy in the pond, the water would speedily become so stagnant as to be prejudicial to health.

For the disappearance of many small creatures which find their way into ponds fish are no doubt responsible. But, on the other hand, there are many ponds in which fish do not exist, and we must therefore look in a different direction in order to discover the agency by which such waters are freed from substances which would certainly contaminate them were they allowed to remain unremoved.

This agency, we shall find, is generally that of insects, for the water is the abode of numberless beings which perform the same offices in their own element as do the burying and dor-beetles upon dry land, preying upon putrid matter, and so removing it before it can be productive of harm.

Not that I mean to assert that these water-insects find their food exclusively in this manner. Many are highly predacious, and feed to a great extent upon prey captured by themselves. But these are never averse to taking advantage of a meal which they find already provided; and I have found, when observing their habits, that if a plentiful allowance of raw meat is placed in the vessel containing them, they will seldom attempt to kill and devour their companions in misfortune, only resorting to such cannibalistic proceedings when the supply of food runs short.

Holding the first place, perhaps, among these aquatic scavengers are the Water-beetles, which populate every pool and pond, from the smallest to the largest, and which comprise more than one hundred and twenty British species, varying in length from one-sixteenth of an inch to one inch and a quarter.

The manner in which the structure of these insects is modified in order to suit them for a sub-aquatic existence is truly wonderful, not the smallest detail having been neglected which could prove of any possible benefit.

In the first place, their bodies are of the flattened cylindrical form with which we are so well acquainted in the case of the various fish, and which we know by practical experience is that best adapted for cleaving through any resisting medium. Moreover, the parts of which the body is composed are so carefully and accurately fitted together that a smooth, polished surface is offered to the water, not the slightest irregularity being found which could in any way retard the progress of the insect.

This careful adaptation of form, however, to the requirements of an aquatic existence would be of little service to the insect were not its locomotive organs modified in a similar manner, for the limbs of an ordinary terrestrial beetle are but ill suited for the task of bearing their owner through the water. A single glance, however, at the legs of a water-beetle will be sufficient to show us that this necessity has been carefully provided for, the hinder pair being altered in a most curious manner in order that they may perform the functions of oars.

Long, flattened, and powerful, and placed farther back than is generally the case, they are fringed with long and stiff bristles, which, being set so closely together that the water cannot pass between them, serve to double the width of the limb, and to convert it into a highly serviceable oar, a single stroke of which will drive the insect for a considerable distance through the water.

But even this is not sufficient, for, were not these swimming-legs furnished with some self-acting means of "feathering," the back-stroke would neutralise the effect of the forward one, just as would be the case with the oars of a boat had they to be forced broadside through the water in order to regain their former position. Even in passing through the air the "feathering" movement is necessary, and, of course, owing to the greater resistance, is even more requisite in the water.

But this difficulty is overcome in a wonderfully simple and yet ingenious manner, for, as the return stroke is made, the limb mechanically turns sideways, thus presenting its edge only to the water. At the same time the bristles collapse and lie flat against the leg, which then cleaves through the water at the expense of very little exertion on the part of the insect.

A very similar plan is adopted by the North

American Indians, who do not raise their paddles into the air after each stroke, but merely turn them sideways, when they cut through the water without offering any resistance.

The first and second pair of legs are not formed for swimming purposes, but are used chiefly in the capture and retention of prey.

Even yet certain requirements are wanting in order to enable the beetle to live a truly sub-aquatic life.

Being a perfect insect, it must, of course, breathe atmospheric air, for it is not provided with the gills which enable fish and various other beings to extract the needful oxygen from the water in which they dwell. And, more than this, it must respire at very frequent intervals, a constant supply of air being necessary for its well-being.

Now, were it obliged to seek the surface for each respiration, its natatory powers would be of little service to the insect, which would be unable to remain beneath the water for more than a few seconds together, either in searching for prey or when attempting to escape from any foe. So, a wonderful provision is made which allows the beetle to be submerged for a considerable space of time, by enabling it to take down with it a supply of air sufficient for a long series of respirations.

This air is enclosed in a reservoir, if we may so call it, which exists between the wings and the inner surface of the elytra. When the insect wishes to breathe, it ascends to the surface and there rests suspended with the head downwards, and the tail slightly projecting from the water. The elytra are then slightly separated from the body, the exhausted air expelled, and a fresh supply taken in its place, the operation being accompanied by a curious popping sound which is audible at some little distance.

On a warm sunny day multitudes of water-beetles may be seen thus engaged in almost any pond, the heat of the sun tempting them to remain for a time at the surface, instead of diving as soon as their respiration is completed. Some caution, however, is necessary in approaching them, for they are easily alarmed, and are sure to take fright if a shadow fall upon them, or if a heavy footfall disturb the surface of the water in ever so slight a degree.

One point still remains to be explained with regard to this system of respiration. How is the air contained between the wing-cases and the abdomen to be introduced into the tracheæ, or breathing-tubes, which pervade the body?

In a very simple manner. The spiracles, or breathing-holes, which in most insects run along the sides of the body, are in the water-beetles transferred to the upper surface of the abdominal segments, so that they open into the air-reservoir itself, the insects being thus enabled to breathe as freely when beneath the water as when upon land.

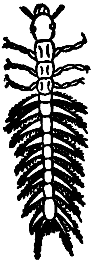
Of course this reservoir of air increases the buoyancy of the insect to a very great extent, as may be easily seen by placing a water-beetle in a glass jar filled with water. It will be found that when the beetle dives to the bottom of the vessel it can only retain its position, unless provided with some object to which to cling, by means of a perpetual series of strokes with the swimming-legs, the slightest cessation of its efforts obliging it to return immediately to the surface.

Wishing to ascertain the length of time during which one of these beetles can remain under water, I made a series of experiments, and found that, under ordinary circumstances, the insect seldom remains submerged for more than fifteen or twenty minutes without replenishing its supply of air. This period, however, can if necessary be considerably extended, for, by alarming the beetle as often as it attempted to rise, I induced it to spend one hour and ten minutes without visiting the surface, during which time it seemed in no way incommoded by the deprivation of air. Upon another occasion the same beetle spent one hour and twenty-seven minutes under water, lying motionless beneath a stone upon the floor of its prison. At the end of this period the necessity for a renewal of the air-supply seemed to become imperative, for the insect rose hurriedly towards the surface, and, cleverly avoiding the pencil with which I attempted to stop its progress, quickly protruded the extremity of the body from the water, took in a supply of air, and again dived, the whole operation occupying only a second or two of time.

In order to allow them to seek fresh hunting-grounds if their food-supply become exhausted, the water-beetles are furnished with broad and powerful wings, which bear them as easily through the air as do their oar-like legs through the water. They seem generally to fly by night, and, as, with the exception of the little "Whirligig" beetles, they cannot take wing from the surface of the water, they generally ascend the stem of some water plant for a few inches, thus gaining a post of vantage from which they can take to flight. When they wish to re-enter the water, they have a curious habit of suddenly folding the wings, and allowing themselves to drop from a considerable height upon the surface.

Whirligig Beetle (*Gyrinus natator*) magnified.

With at any rate the smaller species I think that this must be from necessity, for I have noticed that when a water-beetle has been taken from its native element for any length of time, and the body allowed to become perfectly dry, it has been unable to re-enter the water until plunged forcibly beneath the surface. It may be, therefore, that the fall from a height answers the same purpose, and saves the insect the trouble of finding a convenient water-plant down which it might crawl until submerged, a plan which it would otherwise probably be obliged to adopt.



Larva of Whirligig Beetle (magnified).

Be this as it may, the insect usually takes to the water in the manner just described, sometimes, however, making a curious blunder, and allowing itself to fall upon the roof of a greenhouse, or similar building, evidently mistaking the glass-covered roof for the surface of the water. This mistake is mostly made by moonlight. A friend tells me that he has often known several beetles to thus descend upon his greenhouse in the course of a single evening, some, which had presumably fallen from a greater height than their fellows, being quite stunned by the shock.

Graceful and active as are the water-beetles both in the air and in the water, they are the very incarnation of awkwardness upon dry land. Their long hind-legs, which are formed only for the one movement necessary for swimming purposes, are under such circumstances of no use to them whatever; the remaining pairs are so small as to be little more serviceable, and the insects tumble about in the most ludicrously ungraceful manner, strongly reminding the observer of the motions of a human being when attempting to skate for the first time.

If one of these insects be placed upon its back it is quite unable to recover its position, and merely beats the air wildly with its long hinder limbs, the result being, if it lie upon a polished surface, that it revolves with astonishing speed until, checked possibly, by the giddiness consequent upon its rapid rotation, it gives up the attempt and lies quietly, only to repeat its efforts after the lapse of a few moments.

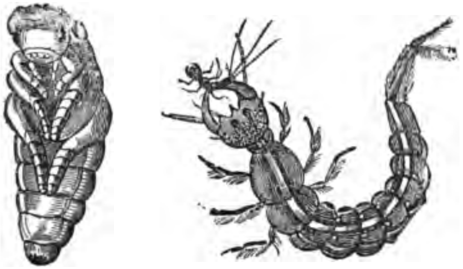
The larvæ of the water-beetles, like the perfect insects, feed upon flesh, either living or dead, and are furnished with large and powerful jaws to aid in the capture and demolition of their prey. These jaws are formed after rather a curious fashion, being perforated throughout their length as are the poison-fangs of a serpent, so that they serve, not only to capture and retain the prey, but also as a medium through which the juices of the victim can be sucked into the mouth.

As its legs are not formed for swimming purposes, the larva travels through the water in a very different manner from that adopted by the perfect beetle, causing its body to undulate like that of an eel, and so progressing with some little speed. Its movements, however, are scarcely so rapid as are those of many of the creatures upon which it preys, and it therefore generally lies concealed upon the mud at the bottom of the pond, its dingy brown hues harmonising with those of the surrounding objects, and enabling it to await its opportunity without fear of detection. No sooner does an insect or other small creature appear in the neighbourhood of its hiding-place than the larva slowly moves forth, glides beneath the body of its intended victim, and seldom fails to make a fatal stroke.

But, predacious though it be, the larva of the water-beetle is no more averse than is the perfect insect to availing itself of a meal which it may find already provided, and is sure to attack any decaying animal matter which may find its way into the pond. We must, therefore, rank it as one of the water-scavengers, and accord it a like position with that to which the perfect insect is entitled.

At the extremity of the body of the larva will be seen two appendages fringed with rather long hairs. These serve, when elevated above the surface of the water, to transmit air to the breathing-tubes which traverse the body, the insect being thus enabled to respire in safety while the whole of the body is submerged.

When the period of its larval existence has expired, the grub makes its way out of the water and burrows into the earth by the borders of the pond, constructing therein a kind of chamber in which it turns to a pupa, and which it does not leave until after it has assumed its perfect form. The time occupied in development varies considerably, depending upon the particular species, and also upon the season of the year.



Pupa and Larva of Great Water-beetle (*Dyticus marginalis*).

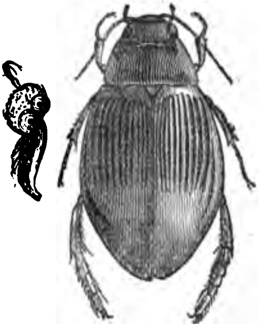
As a type of the group we will take the Great Water-Beetle (*Dyticus marginalis*), which is to be found plentifully in almost every weedy pond throughout the country.

This is one of our largest British water-beetles, measuring upon an average nearly an inch and a quarter in length, and being broad and bulky in proportion. In colouring it is not a very striking insect, the upper surface being of a deep olive-green hue, with the exception of a broad band of dull orange which borders the thorax and the outer margin of the wing-cases; to this band the specific name of *marginalis* is due. Upon the head is a V-shaped mark of a reddish-yellow colour, while two spots of a similar tint are to be seen beneath the eyes. The antennæ, the lower parts of the body, and the legs are of an uniform dull yellow-brown colour, very similar to that of the band which runs round the thorax and elytra.

The generic name of *Dyticus* is from the Greek, signifying a diver, and being therefore very appropriate. The name is very frequently, although wrongly, written as *Dytiscus*, the additional *s* having probably been first interpolated by a printer's error, and having escaped subsequent notice.

The two sexes of the beetle are wonderfully distinct, and can be separated even at a casual glance by the structure of the wing-cases, which in the male are smoothed and polished, while in the female they are deeply grooved for about two-thirds of their length. The feet, moreover, of the front legs of the male are formed in a very singular manner, the three basal joints being flattened into an almost circular plate, the lower surface of which is furnished with an infinitude of suckers, very similar to those found upon the arms of the cuttle-fish.

These vary greatly in size, one in particular being far larger than the rest, and occupying about one-sixth part of the whole surface. Then there is another of rather lesser dimensions, while the remainder of the pad is filled by a multitude of far smaller size, whose real nature cannot be seen without the aid of a microscope. These latter, when carefully examined, are seen to be placed at the extremities of long and slender foot-stalks, and bear a considerable resemblance to long-necked and wide-mouthed champagne glasses.



Great Water-beetle (*Dyticus marginalis*) Female, and anterior foot of male.

The feet of the second pair of legs are modified in a somewhat similar manner, although by no means in so great a degree. The three basal joints, however, are visibly flattened, and an examination with a powerful magnifying-glass will at once show that the lower surface is closely studded with suckers, all of which, however, are of very minute dimensions.

So powerful is the action of these suckers that the beetle is able to cling to, and even to ascend, a smooth perpendicular surface which to any insect of like size not similarly gifted would be altogether inaccessible.

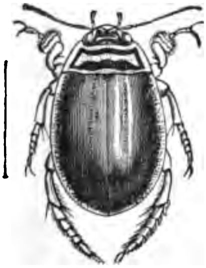
The coxæ, or hip-joints, if we may so call them, of the hinder pair of legs are furnished with two sharply-pointed processes, which, whether knowingly or not, are under certain circumstances employed by the insect as weapons. If one of these beetles be held in the closed hand, for instance, it will at once attempt to escape by working its way backwards, during which process these curious projections are apt to inflict a slight wound upon the skin of the captor. That they are intended by nature as weapons, however, is extremely improbable, for the *Dyticus* has few enemies which would be likely to hold it in such a manner that they could be employed with any effect; and it is scarcely likely that they were furnished for the sole purpose of pricking the hands of human beings.

Like the burying-beetles, the *Dyticus* possesses the power of emitting a peculiarly offensive fluid when provoked or alarmed, this liquid, however, proceeding from the junctions of the head, the thorax, and the abdomen, but not from the mouth. Under certain circumstances, perhaps, this secretion may be employed as a weapon of defence.

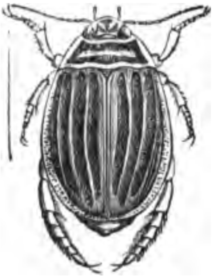
The life of the *Dyticus* is far more prolonged than is generally the case with insects, our present species having been kept in captivity for three and a half years. A still more remarkable existence of unusually protracted existence occurs with a continental species, a specimen of which was kept alive by Dr. Sharp for nearly five years.

Six species of *Dyticus* are known to inhabit Great Britain, two only of which, however, are commonly to be met with, the rest being either generally rare, or only to be found in certain favoured localities.

Another very common water-beetle is that known as *Acilius sulcatus*, both sexes of which are represented in the accompanying illustrations. It will be at once seen that the peculiar grooves in the wing-cases of the female insect are even more strongly marked than in the case of the *Dyticus*.



*Acilius sulcatus*
(Male).



*Acilius sulcatus*
(Female).

As all the water-beetles are extremely similar in their structure and habits, it will be unnecessary to describe further species, and we will therefore pass on to some of the many insects which assist them in their task of removing the various putrefying substances which find their way into the water. These are many and various, for there are few Orders of insects some of the members of which do not lead an aquatic life at some period of their existence. Every pond, every pool, every stream is the chosen home of vast multitudes of living beings, widely different from one another in structure and habits, perhaps, but all combining in the one work of purifying their liquid home from the many substances which would contaminate it if left unremoved.

Some of these devote their attention to animal matter only; others confine their labours solely to the removal of vegetable substances; others, again, find their food indifferently in both. But all are equally useful, and, with one solitary exception, perhaps—the larva of the dragon-fly, which from its very structure is exclusively a predacious being—there is scarcely an insect finding its home in the fresh water which does not deserve to take rank among our benefactors.

Their labours are concealed from our view, it is true, by the very nature of the element in which they work, and we do not become acquainted with their existence, far less with their life-history, until we direct our attention particularly towards them. But there are few creatures whose habits are more interesting, and any trouble which we may take in investigating into their doings will be well repaid, not only by the gratification which we may receive at the time, but also by the fund of knowledge which we shall acquire by our observations.

# CHAPTER VII.

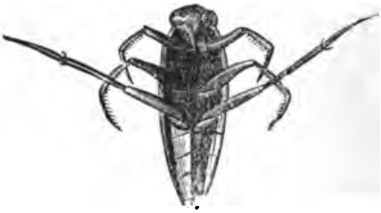
## SCAVENGERS OF THE WATER (*continued*).

The Water-Boatman—Why so called—Heteroptera and their characteristics—How a water-boatman swims—Structure of hinder limbs—Similarity between water-beetle and water-boatman—Mode of breathing—The proboscis and its structure—Its use as a weapon—Early stages of existence—The Water-scorpion—Its peculiarities of structure—Method of capturing prey—Brilliant colouring of body—Respiratory apparatus—Life-history—How the egg is laid—Resemblance of larva and pupa to imago—The Water-gnat—Why so named—Mode of life—Structure of limbs—The proboscis and manner of use—Method of locomotion—Life-history—An "imperfect-perfect" insect—Food of the water-gnat.

One of the most remarkable of the aquatic scavengers is the well-known Water-Boatman (*Notonecta glauca*), an insect which derives its popular title from the peculiar resemblance which it bears to a boat with extended oars when resting, in its favourite attitude, upon the surface of the water. This insect belongs to a different order from those with which we have had previously to deal, and therefore requires a few words of description before we enter upon an account of its life and habits.

The order in question is known by the title of Heteroptera, a word which signifies "different wings,' and which has been selected for the group on account of a peculiarity in the upper wings of the insects comprised in it. Hard and leathery at the base, the remainder is membranous and transparent, the organ being thus composed of two tolerably defined portions of totally distinct character. The upper pair are larger than the lower, and cover them while not in use, being, in fact, very similar in function to the elytra of the beetles. The body is always more or less flattened, and the mouth is furnished with a sharply-pointed beak, or proboscis, which springs from the front part of the under surface of the head.

The water-boatman, when in the water, may be at once recognised by its remarkable habit of swimming upon its back, a peculiarity which has earned for it the generic title of *Notonecta*, or "back-swimmer." When in this curiously reversed position the insect certainly does bear a wonderful resemblance to a boat, the raised suture of the elytra forming the keel, and the likeness being greatly increased by the manner in which the long oar-like hinder limbs lie extended upon either side of the body.



Water-Boatman (*Notonecta glauca*).

These swimming-legs are formed upon precisely the same principles as are those of the water-beetles described in the preceding chapter, being furnished with similar fringes of long stiff hairs, which serve to increase the width of the limb, and possessing the same curious property of presenting their edge only to the water while being drawn back for a second stroke. As is the case with those insects, too, the front pair of legs seem intended solely for the purpose of capturing and retaining prey, for they are furnished with sharp spines, and are also capable of being folded tightly against the body, so that the victim, when once seized, has but little chance of escape.

The method of breathing, too, is exactly similar, and can be watched with perfect ease, owing to the transparent nature of the wings and their cases. A small bubble is always to be seen adhering to the apex of the elytra, this consisting of the air which has been exhausted of its oxygen during its passage through the respiratory system, and which will shortly be cast off in order that a second may take its place.

A very close examination is necessary in order to detect the antennæ, which, instead of being large and prominent, as is usually the case with insects, are extremely small and insignificant, lying concealed in two little grooves just beneath the eyes.

The water-boatman possesses the curious power of taking to flight from the surface of the water, which operation it performs in a very remarkable manner. First diving to some little distance, it suddenly rises, altering its usual position, and ascending with the head uppermost. As soon as it reaches the surface a powerful stroke is given with the swimming-legs, which serves to jerk the insect for some inches into the air. No sooner is it free of the water than it unfolds its wings, and takes to flight before it can fall back into the pond.

Upon a fine sunny day the water-boatman may be seen in numbers in almost every pool, some resting motionless with extended limbs, while others adopt an equally singular position. Instead of lying upon their backs they almost sit upon the water, the wing-cases being partially opened, and the wings slightly protruding. If not disturbed, they will often bask for hours in this extraordinary attitude, seemingly absorbed in the enjoyment of the cheering warmth.

The water-boatman is a highly predacious insect, but will generally prefer a meal which costs him no trouble in the capture. If a piece of carrion happens to fall into the water it is sure to be attacked by the boatmen, which suck its juices by means of the powerful proboscis with which the mouth is furnished.

This organ can also be employed with considerable effect as a weapon of offence, and, if the insect be carelessly held, will often inflict a rather painful wound upon the fingers of its captor. I once had practical experience of this fact, and did not forget the circumstance for some hours afterwards, the puncture causing my finger to swell considerably, and to ache with a peculiar dull throbbing pain, similar to that produced by the sting of a bee. I cannot but think that in these cases the insect must introduce a drop of saliva into the wound, as such results could scarcely follow from the mere prick of an organ not larger than an extremely fine needle.

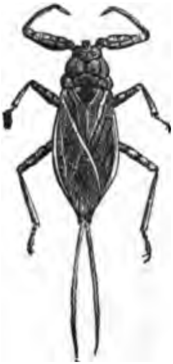
In its earlier stages of development the water-boatman presents little outward difference from the perfect form, the chief distinction lying in the absence of wings, which in the larva are entirely wanting and in the pupa are only rudimentary. In this latter stage of its existence the insect continues to lead an active life, unlike the beetles and flies, which spend that period of their development in a state of quiescence.

Closely allied to the water-boatman are a number of small insects comprised in the genus *Corixa*, many of which are to be found in the greatest profusion in every pool and pond. One of the commonest of these, *C. striata*, is shown, much magnified, in the accompanying illustration.

*Corixa striata.*

ANOTHER very curious insect is the Water-Scorpion (*Nepa cinerea*), a very plentiful species in weedy and muddy ponds. Like the water-boatman, it is a member of the Heteroptera, and agrees with that insect in the principal peculiarities of its structure.

Outwardly, however, the two creatures resemble each other but very slightly, and, indeed, without tolerably close examination, would scarcely be supposed to belong to the same group of insects. Yet the structure of the wings, the form of the body, and the position of the proboscis are essentially alike, and determine without doubt the true position of the water-scorpion in the insect world.



Water-Scorpion
(*Nepa cinerea*).

One of the most important points, perhaps, in which the scorpion differs from the boatman is in the structure of the hinder legs, which are not formed so much for swimming as for walking purposes. For it is not one of the insects which have been gifted with speed and agility in order to aid it in the capture of its victims, but is obliged to seek its prey by means of very different tactics from those employed by the boatman or the water-beetles. Its principal assistance lies in the form and colour of its flat dingy body, which, when the insect is lying in wait, after its fashion, amongst the *débris* which collects at the bottom of every pool, bears so wonderful a resemblance to a withered leaf that even the sharp-sighted water-insects pass directly over their hidden destroyer in blissful unconsciousness of its presence. No sooner is this the case than the fore-limbs are suddenly extended, the victim grasped between them, and the water-scorpion proceeds to feed upon the juices of its victim.

By most people these same fore-legs would be mistaken for jaws, to so great a degree do they lose their limb-like appearance and assume that of mandibles. This modification in form is invaluable to the insect, for these legs are not only serviceable for the capture of prey, but, as the joints close upon one another, like the blade of a clasp-knife, are still more useful in preventing the escape of the victim, which, when once seized, is doomed beyond all hope of release.

It is very generally thought that the water-scorpion is entirely predacious, in the sense that it depends wholly for its subsistence upon the captives which its cunning and address allow it to make; but this, I think, is a very mistaken idea. I have now before me, in a small glass vessel, a specimen of the insect, which for the last seven hours has been uninterruptedly feeding upon a piece of raw mutton introduced into its prison. And this is clearly from choice, and not from necessity, for in the same vessel are a number of the small insects and larvæ upon which it is generally supposed to prey, but which it has entirely neglected.

From this experiment we may, as I think, fairly rank this insect with the multitudinous beings which act as scavengers of the water, although, like many of its comrades, it does not confine its attacks to decaying matter only.

Neither does it invariably make the water the scene of its operations, for I once came upon a specimen buried in the mud several inches from the edge of the pond, with the extremities of its jaw-like legs just projecting above the surface, in readiness to seize any insect which might be unfortunate enough to venture within its reach. When I found it, it had just captured a fly, by whose struggles to escape from its unseen adversary I was attracted to the spot.

The sombre colours of the water-scorpion are predominant only when the insect is at rest, for when the elytra are raised, as during flight, the upper surface of the abdomen and the base of the wings are seen to be of an exquisite rose-colour, contrasting very strongly with the brown hue of the remainder of the body.

At the extremity of the abdomen are found two filaments, about half an inch in length, which are often considered as the organs of some stinging apparatus. This, however, is very far from being the case, the appendages in question merely serving to transmit air to the breathing-holes, or *spiracles*, which are placed at the end of the body, when the insect is submerged, their tips just appearing above the surface of the water, and so obtaining the supply necessary to the insect without obliging it to leave its retreat and expose itself to the attacks of enemies.

The life-history of the water-scorpion is of a very curious nature, the egg-state being especially remarkable. When examined beneath a powerful lens, each egg is seen to be armed with seven horn-like projections, which are placed in a circle around its base. These serve to retain it in the position chosen by the mother, which is invariably a hole pierced by the long ovipositor in the leaf of some aquatic plant, the water-lily being, perhaps, the favourite. The egg, being inserted into the perforation, is thus held securely until the time comes for the larva to emerge.

Before the eggs are deposited each fits into a kind of cup formed by the horns of the one below, in order that space may be economised as far as possible.

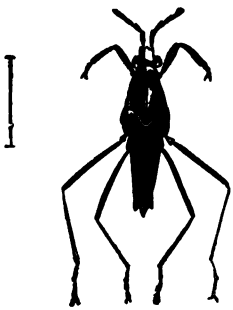
The larva and pupa are by no means unlike the perfect insect, although, of course, the wings are not developed. The long spikes at the end of the abdomen, too, are represented by merely a sharp projection. Yet the general appearance is so similar that the species of the insect could hardly be mistaken, even by those unacquainted with the introductory stages of its existence.

ONE of the most plentiful of the aquatic insects, and one which, from the nature of its habits, is more generally noticed than any other, is the so-called Water-Gnat (*Hydrometra gibbifera*), one of several species which derive their popular name from the resemblance borne by them to a gnat from which the wings have been removed. Like the water-boatman and the water-scorpion, the water-gnat is a member of the order Heteroptera.

Water-Gna (*Hydrometra gibbifera*).

It is placed, however, in a different family, the members of which have very decided characteristics of their own. These insects are scientifically termed *Hydrometridæ*, or "water-measurers," owing to the curious manner in which they seem to measure out the water with their long slender limbs.

Contrary to the usual custom of aquatic insects, which seldom rise to the surface excepting when in need of air, the water-gnats spend but little of their time submerged, and may generally be seen either resting motionless upon the water or traversing the surface with wonderful speed. In fact, they travel upon the water with far more ease and rapidity than do most insects upon dry land.



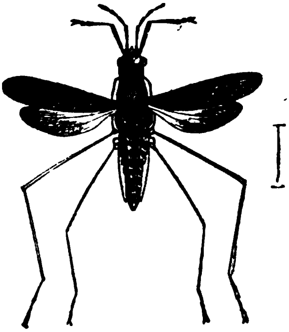
Water-Gnat, at rest.

In order to enable them to perform this task, the feet and the lower surface of the body are thickly clothed with short velvety down, which is imbued with some oily liquid, and so resists the action of the water. If the feet be moistened with spirits of wine, this power is at once destroyed.

The fore-limbs are comparatively small, and seem to be employed solely for the purpose of seizing and retaining the prey. For this function they are admirably adapted, for they are armed with sharp, curved claws, which serve to seize the victim, and can be folded tightly against the body if required, the captive being thus securely imprisoned, and placed, moreover, in the most suitable position for the employment of the proboscis.

This organ is much longer than in the water-scorpion, and, when not in use, is hidden away beneath the thorax, as is the case with all heteropterous insects. Although sharply-pointed, it does not appear to be used as a weapon of offence, as is the same organ in the water-boatman, the strength of the insect being, perhaps, insufficient to force it through the skin of its captor.

The middle pair of legs form the organs of propulsion, and serve to drive the insect over the surface of the water with astonishing rapidity. These limbs are of extreme length, being in some species almost twice as long as the body. The hinder legs appear to act as a rudder, by which the insect is able to direct its course, for they are generally held extended behind the body, and seem never to be used in the actual stroke.



Water-Gnat, flying.

It will be remembered that the larvæ and pupæ of the water-boatman and the water-scorpion are very similar in general appearance to the perfect insects, from which they differ chiefly in the absence of wings. In the case of the water-gnat, however, we have a still greater difficulty with which to deal when separating the introductory from the perfect stages, for the wings are not invariably developed even in the imago, being often as rudimentary and useless for flight as in the pupa. Thus we have the curious spectacle of an insect performing all the functions of its perfect life while seemingly in only the pupal stage of development.

This imperfect-perfect stage is common to many heteropterous insects, the winged form in some species being of excessive rarity, while in many others it is only occasionally met with.

Although the water-gnats feed largely upon prey captured by themselves, they seem always ready to avail themselves of a meal upon the body of any dead creature with which they may happen to meet. I have now before me several of these insects feeding voraciously upon a morsel of raw beef, which seems to entirely engross their attention, as they entirely neglect the small insects upon which they usually prey, and of which there are several in the same vessel. Indeed, it would seem that most of the aquatic insects are always willing to take advantage of a meal which they have not had the trouble of providing for themselves, and that they seldom evince their cannibalistic propensities unless the food-supply should run short. We may, therefore, I think, fairly rank them amongst our insect friends, helping, as they do, to clear the water in which they dwell from the noxious substances polluting it, and which, but for their efforts, would probably be productive of serious harm.

I have not, of course, described one hundredth part of the many aquatic beings which deserve to be ranked under this category; for such a task our space is inadequate. But I have selected typical species, which are not only perhaps the most interesting members of the several groups to which they belong, but which are, moreover, so universally plentiful that they may be captured without difficulty by any one wishing to study their habits for himself.

So far we have confined ourselves to insects feeding upon animal substances only: in the following chapter I shall describe some of those found to devote their attention to vegetable matter, which, although less harmless during putrefaction than that of an animal nature, is yet all the better for removal.

## CHAPTER VIII.

### SCAVENGERS OF THE WATER—(*continued*).

The common gnat—Not a foe, but a friend—Life-history—The egg-boat—How constructed—The larvæ and their structure—Mode of respiration—Food—The pupal condition—Emergence of perfect insect—How the wings are dried—Beauty of the gnat—Structure of the proboscis—The Caddis-fly—The Trichoptera and their distinguishing features—How the caddis-fly lays her eggs—Life-history—" Cases "—Pupal existence—Number of species of caddis-flies—The Great Caddis-fly—Stone-flies—Characteristics of the Neuroptera — Early existence of the Stone-fly — Discrepancy in size between male and female imago—The May-fly—Duration of life—Life-history—How the larva swims—Work performed during larval existence—The pupa—The pseudimago—The perfect insect—The Drone-fly—Life-history—The grub and its habits—Its telescopic tail—" Rat-tailed " Maggots—Pupal condition—Resemblance of imago to bee—Summary.

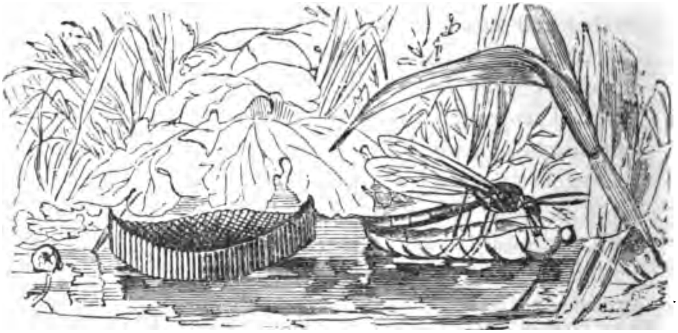
THAT the first example selected as a type of this division of the water-scavengers should be the common Gnat (*Culex pipiens*) will, no doubt, cause some surprise to many of my readers, who have probably been accustomed to look upon it in a far different light from that of a beneficial insect. Nevertheless, unappreciated though it may be, the gnat yet deserves to take high place in the ranks of our insect friends.

I cannot deny that it is, under certain circumstances, a very unpleasant creature,—a fact which can scarcely be doubted by any one who has had practical experience of its powers of annoyance. But we have no right to look upon it in the light of a foe on this account alone. Not one gnat in a million ever meets with a human being. Moreover, only the female gnats possess the power of biting, and it is therefore evident that the insect must have been created for some other purpose than that of annoying mankind. And to discover this purpose we have not very far to seek, for an examination of its life-history is all that is necessary to assure us that its good offices far outbalance its bad qualities.

This life-history is of a singularly interesting nature, all three of the introductory stages of the insect's existence being equally curious and wonderful.

The egg, although placed in the water, yet depends for its welfare upon a constant supply of air and light, two commodities which it would be little likely to obtain were it deposited in the ordinary manner, for its specific gravity being greater than that of the surrounding medium, it must inevitably sink to the bottom unless some special precaution be taken to prevent this catastrophe. And this we find in the method adopted by the parent insect when laying her eggs, a proceeding which may be briefly described as follows.

Resting her front legs upon a straw, twig, or other floating object of small size, and placing the middle feet on the surface of the water, the mother gnat crosses her long hind legs behind her, so that they resemble in form the letter X. In the apex of the angle thus formed she places an egg, with the larger end downwards, preventing it from sinking by the grasp of her limbs. By the side of this a second egg is placed, and by the side of that a third, each being securely fastened to the preceding by a powerful adhesive fluid which is secreted by the insect, and which is impervious to the action of water. This process is continued until the whole of the eggs are deposited, at the end of which time a kind of boat is formed, which floats easily upon the surface of the water. And, more than this, it is so beautifully constructed that, even if forcibly submerged, it rises unhurt as soon as it is released, the water which it has taken in being ejected, just as is the case with our self-acting life-boats.



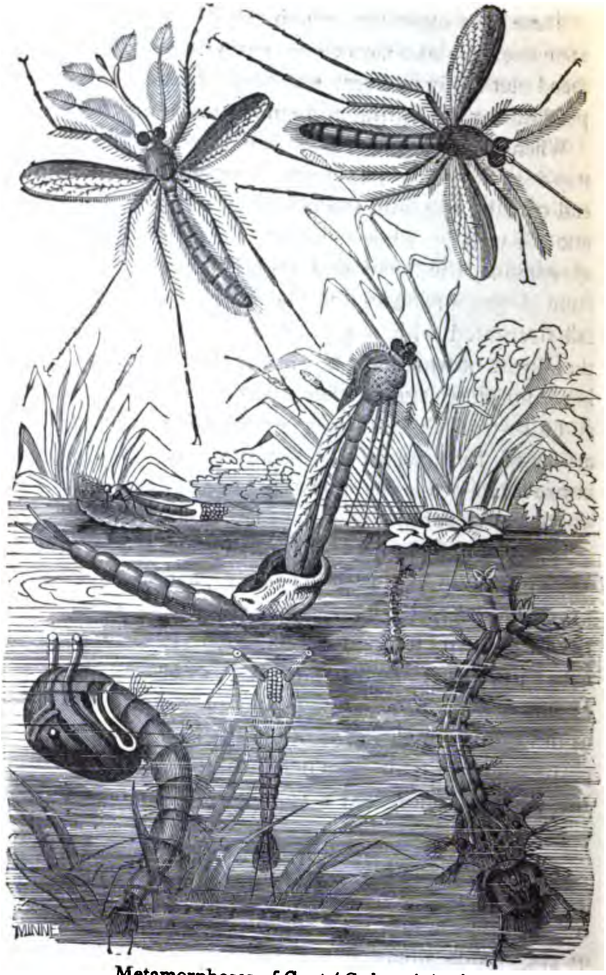
Egg-boat of Gnat (highly magnified).

These little egg-boats, which are of very much the same size and appearance as caraway-seeds, may be found plentifully in every water-butt or semi-stagnant pond during the spring and summer months.

When the time arrives for the larvæ to emerge, a trap-door, if we may so term it, opens at the lower end of each egg, and the little grubs make their way into the water. They are curious little creatures in appearance, the head and thorax being remarkably large in proportion to the size of the body, and the tail decorated with a peculiar fringe-like apparatus, the object of which will be shortly explained. Springing from either side of each segment of the abdomen, and also from the thorax, is a tuft of fine hairs, which are used for purposes of natation, the larva being unprovided with the powerful swimming-legs with which the generality of water-insects are furnished.

Many water larvæ breathe in much the same manner as do the fish, the water passing over gills, which extract the necessary oxygen and convey it into the respiratory system. This is not the case with the gnat larva, however, whose well-being depends upon a constant supply of atmospheric air, in obtaining which the curious anal fringe comes into play. This organ has been so well described by Mr. Rymer Jones, that I cannot but quote his own words :—

"To the extremity of the tail," he says, "is appended a group of movable leaflets or fins, so disposed that by their action they sustain the larva at the top of the water, where it generally remains suspended



Metamorphoses of Gnat (*Culex pipiens*).

with its head downwards. Such a position would obviously render respiration impossible were there not a corresponding arrangement of the breathing-organs to allow of free communication with the air. For this purpose, the respiratory tracheæ (or tubes with which the body is permeated) are found to be connected with a tube appended to the antepenultimate segment of the abdomen, the perforated extremity of which, being raised above the water, procures from the atmosphere the oxygen required for respiration."

This curious organ, in fact, answers precisely the same purpose as do the long filaments which proceed from the extremity of the abdomen of the water-scorpion, or of the fringed apparatus which terminates the body of the *Dyticus* larva.

It is during this stage of its existence that the gnat performs the work which renders it so useful to mankind, the food of the grub consisting of the various particles of animal and vegetable matter floating in the water which it inhabits, and which are left untouched by the larger aquatic insects.

After several changes of skin the gnat larva completes its growth, passes into the next stage of its development, and becomes a pupa. During this period of its existence it is still active, and can traverse the water with considerable speed by means of the fin-like apparatus with which the tail is provided. It no longer takes nourishment, however, the organs of the mouth being entirely covered by the pupal envelope.

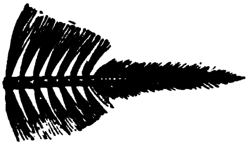
The appearance of the insect is now considerably altered. The head and thorax are no longer separate, but are fused, so to speak, into one large mass, in which the rudiments of the organs belonging to the future imago may be easily detected. The peculiar respiratory apparatus attached to the tail of the larva entirely disappears, its place being taken by two small tubes proceeding from the upper part of the thorax, which are connected with the breathing-tubes pervading the body, and which, when the insect is lying at rest, project slightly above the surface of the water.

It will be seen that the attitude assumed by the pupa while floating is very different from that adopted by the grub, for whereas the latter invariably rests with the head downwards, the former is obliged, by the alteration in its respiratory system, to exactly reverse this position, in order to keep the head and thorax at the surface.

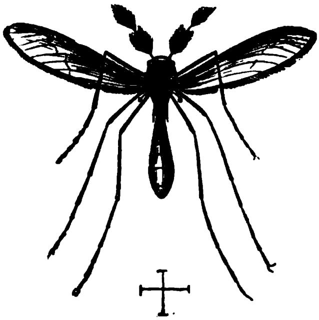
In order to find the reason for this habit, we must consult the manner in which the perfect insect emerges from the pupal shell. Being unprovided with limbs, the pupa is unable to ascend the stem of some water-plant shortly before the time of emergence, as is done by many aquatic insects, in order that the imago may escape all danger of coming into contact with the water which is no longer to be its abode. And, indeed, it would seem almost impossible to those unacquainted with the life-history of the insect that it should be able to make its escape from the pupal envelope without incurring considerable risk of being drowned during the process. But this difficulty is overcome in a beautifully ingenious manner. When the time approaches for the perfect insect to make its appearance in the world, the pupa slightly swells, and this increase of size, by displacing a greater bulk of water in proportion to the weight of the insect, causes a part of the thorax to appear above the surface. The portion thus exposed shortly dries, and slowly splits in a longitudinal direction, thus forming an aperture through which the imago emerges. Then, resting upon its own cast skin, which forms a kind of raft, the gnat dries its wings, which in a few moments are sufficiently firm and strong to bear their owner into the air. Thus the exit of the insect from the pupal shell is managed without the slightest danger of its coming into contact with the water, a danger which, were it encountered, would be almost certainly fatal.

When placed beneath the microscope the perfect gnat is found to be a most wonderful and beautiful object, head, body, wings, legs and even beak being covered with scales of all the colours of the rainbow, very similar in appearance to those found upon the wings of a butterfly or moth. The ridges by which they are traversed, however, project beyond the extremity and form a row of small teeth, which afford a very simple means of identification.

The antennæ, also, more especially those of the male insect, are very beautiful objects, each of the fourteen joints of which they are composed being decorated with a tuft of long hairs upon either side, which are longest near the base of the organ and gradually diminish in size to the extremity. In the female, these tufts are of a far less pronounced character.


Antenna of male Gnat (magnified).

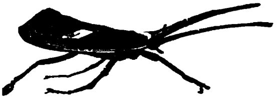
The proboscis of the gnat, by means of which are inflicted the wounds which have earned for the insect its evil reputation, is also well worthy of a careful examination. According to Mr. Westwood, who has succeeded in dissecting it, this weapon consists of seven parts, which are merely the modified organs of the mouth as observed in other insects. These are, a broad and hollow lancet-like piece, which represents the upper lip; a pair of slender sharply-pointed organs, which are modifications of the mandibles, and which are serrated at the tips; a second pair of similar, but more delicate, pieces, representing the *maxillæ*, or lower jaws; a very slender organ, which takes the place of the tongue; and, lastly, a tubular sheath, in which these organs lie when not in use, and which is clearly a modified form of the *labium*, or lower lip.


Female Gnat (showing beak).

This formidable armature is fully developed in the female insect only, the male being unable to inflict the wounds for which his mate is so cordially detested. The pain and irritation caused by the bite are due to the saliva of the insect, which is introduced into the puncture in order to cause the blood to flow with greater freedom, the mere prick of the weapon, of course, being quite insignificant.

The gnat belongs to the order of the Diptera, or two-winged flies, whose principal characteristics have already been described in a previous chapter.

The well-known Caddis-fly (*Phryganea*) is another insect whose larva feeds upon the small fragments of decaying matter of which the mud of fresh-water ponds is largely composed, and which are kept within due bounds by the agency of this and similar beings.

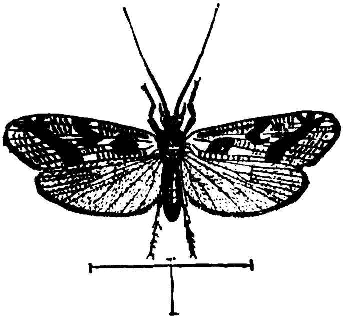


Caddis-fly (*Phryganea*).

This insect belongs to the order known as *Trichoptera*, or "hairy-winged," the anterior wings being closely covered with hair. The hinder wings are generally large, and are always folded when the insect is at rest beneath the upper pair, which are placed tent-wise over the body. The tibiæ of the legs are armed with spines, which, more especially in the middle and hinder legs, are often of very considerable length.

One more characteristic feature of this group lies in the inability of the perfect insect to take nourishment, the mouth remaining in an undeveloped condition.

The caddis-flies possess the power of running upon the surface of the water, and can even exist submerged for some little time, if necessity for so doing arises. Thus the female insect invariably crawls down the stem of some water-plant to the depth of ten or twelve inches when she wishes to deposit her eggs, and can, moreover, swim beneath the water from one plant to another if she be alarmed in any way.



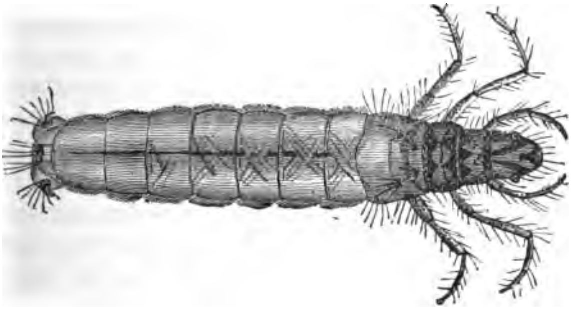
*Phryganea minor.*

Before their deposition, the caddis-fly carries her eggs about with her in a gelatinous mass at the end of her body, the glutinous substance in which they are enclosed serving to affix them to any convenient object, generally the stem of some water-plant.

The Stone-flies (*Perlidæ*) carry their eggs in much the same manner, the black mass contrasting strongly with the light-brown colour of the body and wings.

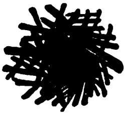
The larvæ are very remarkable objects, long and slender, with no apparent means of escape from their enemies. They are not gifted with the power of swimming, and, were it not for a very curious instinct, would speedily be exterminated by their manifold foes

This instinct lies in the construction of a cylindrical case sufficiently large to enclose the whole of the body, which is formed by the insect from materials of almost every kind,—stones, sand, shells, leaves, and various other objects being generally utilised for this purpose,—firmly fastened together by means of a glutinous secretion not affected by the action of water. In these the larvæ dwell, retaining their position by means of two forked appendages to the tail, and withdrawing even their heads under cover at the first sign of danger.



Larva of Caddis-fly withdrawn from case (highly magnified).

Case of Caddis-fly larva
(side view).



Case of Caddis-fly larva
(front view).

In most of the species of caddis-fly these cases are freely movable, and are carried about at the will of the larva, whose six legs, small though they are, are yet sufficient for the limited amount of locomotion required by the insect. In one or two varieties, however, they are firmly fastened to the lower surfaces of stones or similar objects, the anal claspers being placed at the end of long footstalks, in order to enable the insect to protrude its body to some little distance from its habitation when searching for food.

If a few of these larvæ be taken home and carefully expelled from their habitations, they will at once set to work to repair damages with any small substances which may be supplied to them. They can thus be forced to construct fresh cases of beads, coloured sand, and similar objects, the effect produced being sometimes very curious and pretty.

When their larval growth is completed, the grubs close each end of their tube by means of a silken network, which, while allowing the water to pass through, effectually prevents the ingress of foes. When the perfect insect is about to appear, the pupa leaves its late abode and makes its way to the surface of the water, the larger species usually ascending the stems of aquatic plants, in order that the imago may enter the world in a favourable situation for drying its wings. The smaller varieties perform that operation after the manner of the gnat, resting upon a raft formed of their own cast skin until they are able to rise into the air.

To the angler the caddis-flies are thoroughly familiar, for they form a bait which will often answer when everything else has failed. For these insects appear to be considered as a great dainty by many fresh-water fish, which are always upon the look-out for them in their season as they enter the water for the purpose of depositing their eggs.

As rather more than two hundred species of caddis-fly are known to inhabit Great Britain, it is manifestly impossible to describe all these insects, and we must therefore confine ourselves to a single typical example only, namely, the Great Caddis-fly (*Phryganea grandis*), one of the largest members of the group.

In this insect the wings are so thickly covered with hair that they seem when examined almost to be clothed with fur, the membranous groundwork of the organs being scarcely visible. The body and antennæ are covered with similar hairs, which, as far as the latter organs are concerned, entirely conceal the joints of which they are composed. As is the case with all the caddis-flies, the colouring is of a very sombre character, the hues being simply various shades of brown, with a slight admixture of yellow.

The Stone-flies (*Perlidæ*) which have already been casually mentioned, are, during the earlier stages of their existence, inhabitants of running rather than of standing water, and seem to prefer those parts of the stream where the current runs most swiftly to those where it is comparatively still. They do not belong to the same order as do the caddis-flies, but form one of the families of the Neuroptera, or "nerve-winged" insects.

This can hardly be regarded as a well-chosen title, for it is more or less applicable to any insect in which the wings are fully developed, the membrane of which those organs are formed being invariably stretched upon nervures, which afford a framework of the requisite strength. In the Neuroptera, however, these nervures are far more numerous than is the case with insects belonging to other orders, and divide the transparent wings into a great number of small "cells," which vary in size in different parts of the organ.

In these insects both pairs of wings are used in flight, and are of equal size and solidity; the larva is furnished with six legs; and the pupa is active in some species and quiescent in others.

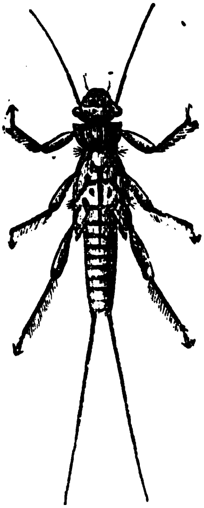
Having now described the principal characteristics of the Neuroptera, we will turn to those of that branch of the order at present under our notice.

As has already been stated, the eggs of the stone-flies are deposited in the same manner as are those of the caddis, the parent insect crawling down the stem of some aquatic plant until she has reached the depth of several inches below the surface. This task duly performed, her business in life is completed, and she seldom survives for more than two or three hours.

The larvæ, when they emerge, do not construct cases for themselves like the grubs of the caddis-fly, but seek shelter beneath stones and similar objects, where they may find protection from their numerous foes. Their food, like that of the caddis larvæ, appears to consist of a mixed diet, composed of various particles of animal and vegetable matter.

The pupæ of the stone-flies invariably leave the water when the perfect insect is about to emerge, generally crawling up the stem of some water-plant in order to secure a favourable situation in which the change may take place. This gained, the pupa sways its body backwards and forwards for a few moments, when the skin splits along the back, and the imago slowly withdraws itself from its late covering.

Upon first emerging, the wings are soft and crumpled, and are barely a tenth of their natural size. In this condition, however, they remain but a very short time, a series of deep inspirations being taken by the insect, and the wings simultaneously waved gently backwards and forwards. By slow degrees the folds disappear, the membrane gains strength, and before very long the insect is enabled to rise into the air, and to take its first journey through the element in which the remainder of its life is to be passed.


Larva of Stone-fly
(*Perla*)
magnified.

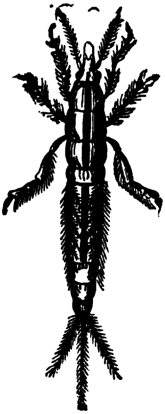
There is a curious discrepancy in dimensions between the male and the female fly, the former being barely one-third the size of his mate. It is commonly the case with insects that the female is the larger of the two, but in few is the difference so strongly marked as in the stone-flies.

Stone-flies (*Perlidæ*).

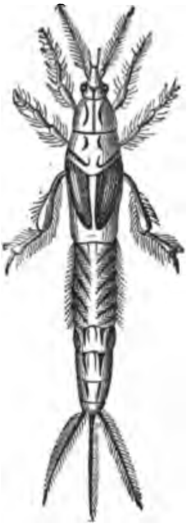
Belonging to the same order are the May-flies (*Ephemeridæ*), proverbial for the short duration of their existence as perfect insects. A far longer period, however, is occupied in the earlier stages of development, the entire life of the May-fly extending over a period of no less than two years.

During this time the insect is strictly aquatic, and lives principally in the mud at the sides of ponds, &c., wherein it makes its burrows. These run horizontally into the mud, and are in shape much like the capital letter U, the tunnel being provided with a double entrance, so that the larva can enter at one and leave at the other.

In these burrows it spends almost the whole of its existence, and, is, consequently, seldom captured in company with other water-insects. In fact, a pond may be industriously searched from end to end by the ordinary means of collecting, and not a single May-fly larva taken, although thousands may be dwelling in the mud. If, however, this mud be stirred up with a stick, or, better still, if a quantity be carefully broken up and examined, the grubs may be found without difficulty.


Larva of May-fly (*Ephemera*) magnified.

These larvæ are curiously like the perfect insect, from which they differ chiefly in the absence of wings and in the great length of the antennæ, which are developed in a manner very unusual in the earlier stages of development. Running along the sides of the body are a series of small plates, which are connected with the respiratory organs, and which are sometimes thought to be also used for purposes of natation. It seems, however, that this is not the case, the insect travelling through the water by means of the sinuous movement described with regard to the grub of the water-beetle. The tail is decorated with three fringed appendages, or *setæ*, as they are called, which are also present in the perfect insect, sometimes, however, being then reduced to two in number.



Pupa of May-fly (magnified).

These larvæ feed entirely upon the vegetable matter of which fresh-water mud is largely composed, and by their incessant labours aid greatly in the purification which is so much required.

When entering upon the pupal stage of their existence they alter but little in form, the principal change being in the appearance of wings, which now begin to show themselves in a rudimentary and imperfect form.

When the time for its final transformation arrives the pupa leaves the water, the fly emerging almost as soon as it is fairly above the surface. The wings are quickly dried, and the insect flies slowly and heavily to the nearest convenient object, where it remains resting for some little time.

Even yet its development is not altogether complete, although it has attained its wings and its mature form, for, after a short time, varying in duration according to the state of the weather, the skin once more splits, and the May-fly, perfect at last, enters upon the final stage of its existence, and joins its companions in the strange dance in which the greater part of the few remaining hours of its life will be passed. The wings are now of a lighter and more useful character, and the setæ springing from the extremity of the abdomen are of greatly increased length.

This curious intermediate stage of development is scientifically known as the "pseudimago," or "false-perfect insect," the female of which forms the "Green Drake" so dear to the souls of anglers. The "Grey Drake" is the perfect female of the same insect.

The May-fly differs from the Neuroptera in general in the size of the hinder wings, which are considerably smaller than the anterior pair, and in some species are almost rudimentary. In consequence of this aberration, some authors have considered that these insects form a separate order, and have described them under the title of Anisoptera, or "unequal-winged" insects.

When once they have attained their perfect form the May-flies take no nourishment, the parts of the mouth being quite undeveloped. It must not be thought, however, that this inability to receive nourishment is the cause of the abbreviated nature of the perfect existence, for there are many insects which will live for many weeks, and even months, without touching food in any form.

OUR last example of the water-scavengers shall be the Drone-fly (*Eristalis tenax*), that brown, active fly which is so common upon flowers towards the end of summer, and which deters many from meddling with it by its resemblance to the common hive-bee. In spite of its somewhat formidable appearance, however, it is perfectly harmless, being provided with no weapon which could by any possibility be used against the fingers of its captor.

Drone-fly
(*Eristalis tenax*).

It seems scarcely possible that so bright and active a being as the Drone-fly should proceed from a larva which spends the whole of its existence immersed in the thickest and most fœtid mud, never quitting its repulsive abode until the time comes for it to enter upon the next stage of its development. Yet such is the case, this curious insect finding a congenial resort even in the most noisome recesses of sewers and drains. And its appearance is as singular as its habits, for a small cylindrical body is terminated by a tail of surprising length, which, moreover, has the curious property of being lengthened or contracted at the will of the insect.

This tail, like the anal appendages with which the water-scorpion, the *Dyticus* larva, and many other aquatic insects, are provided, is connected with the organs of respiration, being, in fact, a hollow tube, through which air is conveyed to the spiracles, or breathing-holes, the extremity always remaining above the surface of the water. The needful supply of oxygen being thus ensured, the insect is able to enjoy an uninterrupted feast upon the semi-putrid substances among which it dwells, and by the removal of which it does so good service to mankind.

Should a sudden shower cause the water beneath which it is buried to increase in depth, the telescopic qualities of this curious tail come into play, the organ being immediately lengthened to the requisite extent. Again, should evaporation take place and the quantity of water become reduced, the tail is shortened in a corresponding degree, the extremity always slightly projecting above the surface, but never so much as to become conspicuous.

At the slightest alarm, such as that produced by a heavy footstep in the immediate neighbourhood, the tail is immediately withdrawn, and is not again protruded for some little time. It is most curious, if some of these larvæ be kept in confinement, to note the manner in which the extended tails collapse if the vessel in which they are imprisoned be slightly jarred, the insects seeming to be actuated by one impulse, so quickly and simultaneously do they take the alarm.

This remarkable organ will doubtless remind the reader of the human diver, and the apparatus used for supplying him with the necessary air during his sojourn beneath the water. The maggot itself represents the diver intent upon his sub-aquatic proceedings, while the elongated tail forms an almost exact parallel of the double air-tube employed, the only difference being that, while the insect conducts the necessary operations for itself, the man is obliged to rely upon the aid of assistants.

Owing to this structure, these larvæ are generally known as "rat-tailed" maggots, their breathing-tubes really bearing some resemblance to the caudal appendage of the rodent animal whose name they bear.

When their growth is completed, the larvæ leave the water and bury themselves in the ground, there remaining until they come forth as perfect insects. As is the case with the blow-fly already described, the larval skin is not shed, but hardens and forms a kind of cocoon in which the pupa lies enclosed.

In spite of its curious resemblance to the bees, the drone-fly has nothing in common with those insects, and belongs to a totally different order, viz., the Diptera, or two-winged flies. As the characteristics of this group have already been fully described, there is no occasion to recapitulate them.

We have now arrived at the conclusion of the first division of our subject, having considered, although but very imperfectly, some of the multitudinous insects which have been appointed by nature to perform the duties of scavengers. We have seen how both the land and the water are equally well provided with these beings, whose life-object it is to remove all such substances, animal and vegetable, as by their putrefaction would become prejudicial to health ; and we have also realised, I trust, in some degree, the wonderful manner in which their labours are performed.

Even were the benefits conferred upon us by these little creatures confined to this one branch of service alone, we should have more than sufficient cause for looking upon them with the eyes of friendship rather than of enmity. And when we recognise the fact, as I hope ere my task is completed we shall, that other and equally important benefits which we daily enjoy are due to the agency of insects, we shall have still further grounds for modifying our former opinions, and for acknowledging the immense debt of gratitude we owe to them.

## CHAPTER IX.

### "BLIGHT" AND ITS ENEMIES.

Aphis, or Green Blight—Its destructive powers—The *Homoptera* and their distinguishing features—Rate of increase of Aphis—Double mode of reproduction—Losses caused by Aphides—Their migratory powers—Enemies of the aphis—Ladybirds—Numbers proportionate to those of their prey—Aphides and Ladybirds in 1869—Early life of the ladybird—Manner in which the eggs are laid—The larvæ and their habits—Their voracity—Do insects feel pain?—The pupa—The perfect insect and its work—Odour of ladybirds—A specific for the toothache—Different kinds of ladybirds—Their variability.

NEXT, we will turn to the group of insects which are of such vast service to us in keeping down the numbers of the aphides, or "green blight," which are so terribly destructive to many of our cultivated plants. Before so doing, however, it will be necessary for us to devote a short space to an account of the life-history of these aphides, in order that the full value of the services rendered to us by their destroyers may be duly appreciated.

The name of green blight" is not a good one, because the insects which form the "blight" are variously coloured, those which infest the broad bean, for example, being black, while others are nearly white, and others are mottled.

These insects belong to a different order from those with which we have previously had to deal, namely, the Homoptera, in which both the upper and lower wings are of a similar character. These wings are membranous, and do not overlap each other when not in use, lying closely against the sides of the convex abdomen. The feet have never more than three joints, and the head is furnished with a sharply-pointed beak, or proboscis, by means of which vegetable juices are sucked into the mouth.

But for their wonderfully rapid rate of increase, these aphides would be productive of comparatively little harm, for they are individually so insignificant than an extremely large number must be present in order to produce any appreciable effect upon vegetation. But, owing to their peculiar method of reproduction, they increase with such enormous rapidity that large tracts of land may be over-run in the course of a few days by the progeny of a single specimen.

As a general rule, an insect passes through three preliminary stages of development—namely, the egg, the larva or grub, and the pupa—before it attains to its perfect condition. But this is the exception only with the aphis, the female of which, incredible as it may seem, produces living young, as perfect, after three or four rapid changes of skin, in all respects as herself, at the rate of from fifteen to twenty per diem, and continues to do so during the month or six weeks of her existence. These, in their turn, give birth, in the course of a few days, to a second generation, these to a third, and so on, the numbers of the insect thus increasing at so extraordinary a rate that Réaumur calculated that the progeny of a single aphis, reckoned to the fifth generation only, would, if unchecked in any way, amount to no less than 5,904,900,000 specimens, a number so vast that it can with difficulty be realised.

A noted mathematician has carried on the calculation yet farther, and finds that, if the increase of the insect were unchecked during a period of three hundred days, the descendants of one aphis alone would suffice to choke up the whole of the world, land and water alike, so that no living being besides themselves could possibly exist.

Happily for us, their many foes keep down their numbers so effectually that we suffer comparatively little from their attacks, in comparison with the absolute ruin which would befall us were their increase allowed to remain unchecked even during the short space of two or three months. Nevertheless, our losses are sometimes very considerable, as may be gathered from the fact that even so long ago as the year 1801 the duty upon hops, a plant which suffers greatly from the ravages of these insects, fell from £100,000 to £14,000 during the season, simply on account of the vast swarms of aphides which made their appearance upon the bines.

Again, some years later on, in 1825, the "fly," as it is termed in the hop-districts, made its appearance in large numbers, the result being that the duty fell to £16,000 only, while in the following season, when scarcely an aphis was to be seen, no less than £265,000 were paid in this manner, an increase of nearly a quarter of a million of money. Once more, in 1833, it was stated that the absence of the blight made a difference of no less than half a million sterling in the revenue receipts.

Nor are their ravages confined to hops alone, for there is scarcely a plant which is not attacked by some species of aphis—leaves, stem, fruit, and even roots being alike the scene of their destructive operations. Wheat crops are often damaged greatly by their ravages; fruit-trees are sometimes stripped of leaves and fruit; there are few who have not noticed the influence of the blight upon rose-trees, and other garden plants; and, to descend to subjects of less importance, we read of willow and poplar trees, thirty or forty feet in height, being utterly destroyed by their attacks.

This damage is not entirely caused, as may be thought, by the weakening effect produced upon the plant by the constant extraction of its juices, but is due, in an almost equal degree, to the deposition of the "honey-dew," as it is called, which is exuded from two minute tubes situated upon the upper surface of the abdomen. This secretion, which is of a highly-glutinous consistency, gradually spreads over the leaves, and, in some aggravated cases, also over the stem of the plant attacked, choking the pores by which respiration is carried on, and so depriving the already debilitated plant of the reinvigorating influence of the atmosphere.

This honey-dew takes the former portion of its name from the peculiar sweetness of its flavour, and the latter from the common idea as to the manner of its deposition. Insects appear to appreciate it very highly, flocking to it in great numbers both by day and night, while ants in particular consider it so great a dainty that they not only force the aphides to exude it when required by gently tapping the little creatures with their antennæ, but actually take them under their protection and guard them from the attacks of their enemies.

THERE are yet one or two points concerning the reproduction of the aphis which deserve special notice, the first being that generation after generation is produced by the female insect without the presence of the male, the progeny in these cases being entirely composed of females. This fact has been satisfactorily proved by many careful investigators, one of whom, the well-known entomologist Bonnet, watched the development of these insects through no less than nineteen generations, no male being permitted access during the whole of this period.

The last brood of the season always consists of males and females both, in tolerably equal proportions, which, unlike most of the females produced earlier in the year, are possessed of wings and the power of using them. It is chiefly at this time of the season that the great migrations take place which are occasionally noticed, the aphides travelling in vast hordes through the air, and often passing over very considerable distances.

Having alighted in their new neighbourhood, the females, departing from their usual method of proceedings, begin to deposit eggs, which, after living through the winter, produce in early spring the larvæ which are to be the progenitors of their species for the forthcoming season.

HAVING now glanced at the life-history of the aphis, and realised in some degree its extraordinary powers of multiplication, we will turn to those insects which form its natural foes.

Of these, the most important are undoubtedly the various Ladybirds, which, both as grubs and as perfect insects, prey upon the aphides, and reduce their numbers in a truly marvellous degree. And, by a wonderful provision of nature, they seem to appear always in numbers proportionate to those of the insects which they are commissioned to destroy, the same causes seeming to operate upon both, and to influence them in a similar manner.

In the year 1869 the aphis was unusually abundant in the Kentish district, so much so that certain crops were threatened with total destruction. The ladybirds, however, appeared in corresponding numbers over the infested districts, swarming in some places to such a degree that, in the language of one observer, "it was difficult to avoid crushing hundreds under foot."

Another writer, in a communication addressed to the *Entomologist's Monthly Magazine*, remarks :— "Norfolk shared the advantages derived from the timely visit of numerous flights of ladybirds, and the plague of aphides, from which vegetation suffered so severely, rapidly disappeared."

These are by no means isolated instances of the case in point, and upon looking back we should find that there has scarcely been a year in which the aphis has been unusually plentiful but has also been remarkable for the increased numbers of the lady-birds, their natural foes. And so effectually do these and their assistant-labourers perform their work that it is generally the case, when the "blight" has been present in excessive abundance in any one year, that the subsequent season is remarkable for its almost entire absence. This was notably the case in the year 1826 before referred to, when the duty upon hops rose to £265,000, after having fallen as low as £16,000 in the preceding autumn, scarcely a solitary specimen of the aphis being seen in place of the vast hordes which had covered the plants only a few short months before.

The eggs of the ladybird are laid in small batches in the midst of the aphides, the young larvæ thus finding themselves surrounded with food as soon as they make their appearance in the world. Of this they are by no means slow to take advantage, and set to work in a very business-like manner, devouring the little creatures one after another, and continuing their task of destruction hour after hour and day after day with scarcely a single cessation.

Each aphis, from the moment in which it is seized to that in which its mangled remnants are cast away, occupies the insatiable destroyer for rather less than a minute, in which period the whole contents of the abdomen are extracted and the softer parts of the body devoured. The head, thorax, and legs are generally rejected, appearing to prove too tough for even the sturdy jaws with which the voracious larva is provided.

Strange to say, however, the terrific onslaught made upon the aphis is not always immediately fatal, for upon several occasions the mutilated insect has been seen to rise and walk away after being thrown upon one side by its captor, actually living for some little time absolutely devoid of internal organs.

This tenacity of life, however, is not peculiar to the aphis alone, but seems to be a characteristic of insects in general. I myself witnessed one case of an even more remarkable nature, and one which I should certainly not have credited had I not been present upon the occasion.

A Wood-leopard Moth (*Zeuzera æsculi*) had been taken by a friend of mine, and, being a female, always the most tenacious of life, was literally drenched with chloroform by its captor, the deadly fluid spreading over body and wings, and entirely obliterating, for the time being, every trace of the markings of the insect. This done, my friend proceeded to remove the internal organs, and stuff the abdomen with cotton-wool, in order that the tendency to become "greasy," characteristic of this and many other moths, might be averted.

The thorax was then transfixed with a pin, and the insect put upon one side for a few moments while the necessary implements for setting out the wings were procured. Meanwhile the moth, in spite of the chloroform and the loss of its internal organs, began to revive, and actually recovered sufficient strength to drag the pin by which it was impaled from the corked board into which it was fastened, and to wander about the table, apparently little the worse for its late experiences.

A very similar case was noticed in one of the entomological journals a short time ago, the insect on this occasion, however, being an example of the Death's-head Hawk-moth.

THE ladybird larva is very unlike the perfect insect, being a slaty-grey grub, about half an inch in length, marked with scarlet and yellow. In the course of from two to three weeks it completes its growth and turns to a pupa, suspending itself by the tail to any convenient object preparatory to the change. After two or three weeks more the perfect insect appears, and again sets to work to destroy the aphides as it did when a grub.

Larva of Ladybird (magnified).

Notwithstanding the fact that it has completed its development, it seems as voracious as ever, devouring upon an average from forty to fifty aphides in the course of an hour. Even this number, large as it is, is sometimes surpassed, and upon one occasion a ladybird was seen to suck the juices of over one hundred specimens within a similar period of time. In this latter case, however, the victims belonged to the aphis which makes the apple its special food, and which is a rather smaller species than that found upon the hop.

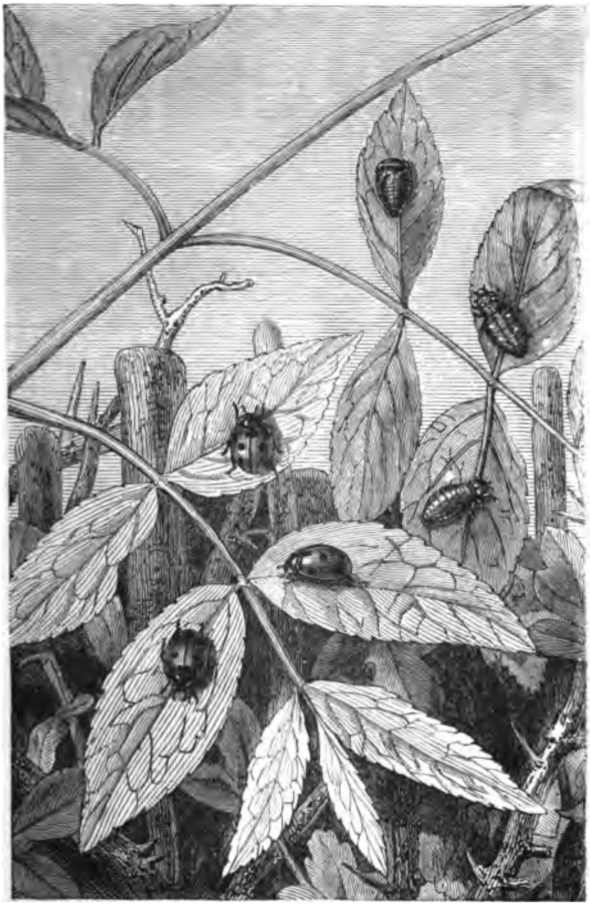
These services can scarcely be over-estimated if we consider the weakening influence which must be exerted upon the plants by the thousands of little beaks busily extracting their juices, and by the glutinous secretion which spreads over the leaves, and so closes the pores as to render them useless for purposes of respiration. Nevertheless, in spite of their manifest value, their services are not always appreciated even by the hop-growers themselves, for upon so recent an occasion as the great visitation of 1869 we read of large numbers of ladybirds being swept up and destroyed, under the impression that they assisted the aphides in their mischievous proceedings.

All the ladybirds are remarkable for a peculiar and very disagreeable odour, which proceeds from a liquid exuded from the joints of the limbs. This secretion seems to be of a similar nature to that which has gained for the well-known Oil Beetles their popular title. When the ladybirds are present in any numbers this odour becomes almost intolerable, and it is said that, during such seasons as 1869, houses have been rendered almost uninhabitable by the hosts of these insects which flocked in at every open window and door, the odour being so intensely powerful that the inmates were fairly driven from the dwelling.

In some parts of the country this peculiar secretion is thought to be a sovereign remedy for the toothache, and is invariably prescribed for that ailment, although one would think that so nauseous a remedy could be little more agreeable than the disease.

Between twenty and thirty species of ladybird are known to inhabit this country, some of which are exceedingly common, while others are correspondingly scarce. One of the most plentiful of these is the insect popularly known as the Two-spot (*Coccinella bipunctata*), from the round black spot which occupies the centre of each wing-case in the typical form. It is, however, an exceedingly variable insect, a very common form being entirely black with the exception of four red blotches upon the wing-cases, one upon the shoulder, and one in the centre of each. Another variety has six of these red markings, the additional pair being situated at the extreme apex of the elytra, and a third form, while retaining the ground colour of the type, differs from it very considerably in the shape and size of the black spot, which loses its circular form, and assumes that of a hollow square, occupying nearly the whole of the apical half of the wing-cases.

Another species, *Coccinella variabilis*, which is not distinguished by any popular title, is even more unstable in its colour and markings, some specimens being red, some brown, some yellow, and others black, while spots, bars, and blotches of infinite diversity adorn the elytra, a number of varieties being thus produced which resemble neither the typical form nor



Metamorphoses of Ladybird (*Coccinella septempunctata*).

each other, but which nevertheless belong to the same species, and which may even be members of the same brood.

This insect is a very plentiful one, and fifteen cr twenty specimens may often be found in the course of a few minutes, no two of which exactly resemble each other in any but structural characteristics.

A third species, the Seven-spot Ladybird (*Coccinella septempunctata*) is distinguished, as both its popular and scientific names imply, by the fact that the wing-cases are ornamented with seven black spots, one of which is situated near the centre and two near the side margin of each elytron, while the seventh, which is common to both, is placed at the base of the suture. This, unlike its fellows, is by no means a variable insect, the specimens differing very little from one another, except, perhaps, to a slight degree in the size of the spots.

# CHAPTER X.

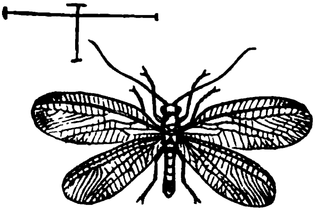
## "BLIGHT" AND ITS ENEMIES (*continued*).

The Lace-wing Fly—Why so called—Its marvellous beauty—Eyes of the Lace-wing—Loss of colour after death—Horrible odour—Life-history—Remarkable egg—Botanists at fault—Voracity of the larva—A novel garment—Pugnacity and cannibalism—The pupa—Small size of cocoon—Emergence of imago—The attractive power of a gas-lamp—Ichneumon flies—Characteristics of the Hymenoptera—Life-history of an Ichneumon-fly—Hyper-parasites—The Ichneumon and the Aphis—Hoverer-flies and their work—Activity upon the wing—Larvæ of the Hoverer-flies—Their voracity—Pupal existence—Abundance of Hoverer-flies in 1869—Value of Aphis-parasites—Summary.

ONE of the most untiring foes of the aphis is the common Lace-wing Fly (*Chrysopa vulgaris*), which, like the Stone-fly and the May-fly before described, belongs to the order of the Neuroptera.

In the insects of that group, it will be remembered, the wings are traversed by a vast number of nervures which divide them into a quantity of cells, none of which are very large, while some are so minute that they can scarcely be distinguished without the aid of a magnifying-glass. This is notably the case with the wings of the Lace-wing Fly, their gauzy nature and wonderfully close and delicate neuration having earned for the insect its popular title.

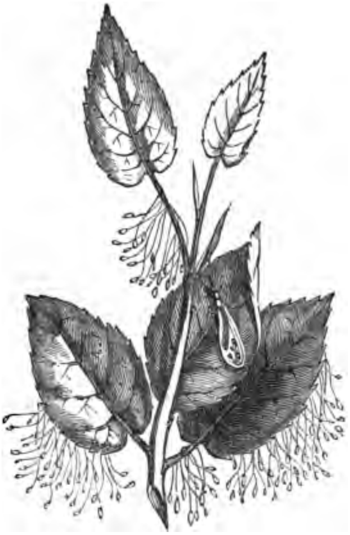
In every respect it is a singularly handsome insect. The head, thorax, and abdomen are of an exquisite pale green tint, which also extends to the wings, these latter organs, however, being highly iridescent, and exhibiting all the colours of the rainbow when the light is playing over them. But the chief beauty of the insect lies in its eyes, which shine like polished gold, and, when viewed beneath the microscope, form one of the most glorious objects that the mind of man can imagine. They seem then to be composed of one mass of fiery jewels, diamonds, emeralds, and rubies clustering closely together, unceasingly interchanging their nature with one another at every movement of the insect, and forming a veritable blaze of light, the wonderful depth and richness of which words are utterly inadequate to express.


Lace-wing Fly.

Unfortunately, this marvellous beauty exists only during the lifetime of the insect. As soon as death supervenes, the tints of the body and wings begin to fade into greyish-yellow, the eyes lose their refulgent brilliance, and in the course of a few hours the appearance of the fly is totally changed. It is still a handsome object, nevertheless, the delicate wings and graceful form investing the insect with a permanent beauty which is not affected by the influence of light and time.

Beautiful as is the lace-wing fly to the sense of sight, it is by no means as agreeable to that of smell, for it possesses the power of exuding at will an odour so fœtid and powerful that few who have once experienced it will care to repeat the experiment. Even the burying-beetles, offensive though they are to the olfactory organs, will hardly compare in this respect with the lace-wing fly—a fact the more remarkable since the food of the latter does not consist of the putrefying matter upon which the former insects subsist.

The eggs of the lace-wing fly are deposited in a most singular manner, which may be briefly described as follows :—



Lace-wing Fly and eggs.

Alighting upon a leaf or twig, the parent insect depresses her abdomen until the extremity just touches the surface upon which she is resting. A small drop of a glutinous secretion is then deposited, and the abdomen suddenly raised. By this movement the viscous fluid is drawn into a long slender thread, which instantly hardens upon exposure to the air, a kind of foot-stalk being thus formed, upon the apex of which a single egg is placed. The process is then repeated, and so on until the whole of the eggs have been laid.

A batch of these little eggs, each at the end of its curious stem, bear a wonderfully close resemblance to certain mosses. To so great a degree is this the case, indeed, that many experienced botanists have been deceived by the likeness, the group of eggs having more than once been figured and described as a veritable species of moss.

Larva of Lace-wing Fly.

The larva is a most voracious creature, devouring the aphides, upon an average, at the rate of two per minute. No sooner is one victim devoured than the insatiable insect is upon the look-out for a second, seizing its prey with the eagerness and fury shown by a dog when capturing a rat.

This extreme voracity seems a characteristic of the insect even under the most untoward circumstances, a fact to which the following anecdote, related by Mr. G. B. Buckton in his "Monograph of British Aphides," bears witness in an extraordinary degree. "A specimen," he says, "was sent to me through the post, having been imprisoned without food for two days. This larva was gummed on a slip of glass, and placed on the microscope stage for drawing. Thus the limbs were incapable of motion for half an hour or more, and in this constrained position it devoured three aphides, one after another, as they were presented to its terrible jaws."

This larva has a curious habit of clothing its body with the empty skins of its victims, the bristle-tipped peduncles with which the segments are decorated serving to retain them in position. After a time the insect becomes entirely concealed beneath its strange garment, and then bears so close a resemblance to a piece of lichen-covered bark that its real nature can with difficulty be distinguished.

These larvæ are wonderfully pugnacious, for if two specimens should happen to meet they invariably fight, the conqueror always devouring his vanquished foe. This ferocious disposition is common to many predacious insects, which war alike upon all beings weaker than themselves, making a meal upon one of their own species with perfect complacency should the two happen to meet.

When the supply of aphides is tolerably abundant, the lace-wing fly passes through the larval state of its development in little more than a fortnight, having in the course of that period disposed of, perhaps, between twenty and thirty thousand of the destructive little creatures. It then spins a cocoon, in which it passes the winter months, the perfect insect not emerging until the spring.

This cocoon is wonderfully small when the size of the insect is taken into account, being little, if at all, larger than a No. 1 shot, the insect lying curled up within it in a peculiarly compact manner. When the time for its appearance in the perfect state arrives, it cuts a curious spiral slit in its silken covering, and through that emerges into the outer world.

This event usually takes place towards evening, at which time the perfect insects may often be seen drying their gauzy wings upon fences and tree-trunks preparatory to their first flight through the air. After darkness has set in they seem to be irresistibly attracted to the gas-lamps in their vicinity, where they may be seen resting upon the panes, lost in contemplation of the mysterious flame. They are also very apt to enter dwelling-houses with the same object in view, and frequently meet with an untimely death owing to the excessive zeal with which they carry out their researches.

NEXT in importance, perhaps, are the various Ichneumon-flies which, in their larval stage of development, find their food in aphides. These insects belong to a different order from those which we have hitherto described, namely, the Hymenoptera, or "membranous-winged" insects. This title is by no means an appropriate one, for it is equally applicable to all winged insects, and affords no point of distinction by which its members can be separated from those belonging to other orders.

The distinguishing features of the group may be briefly summed up as follows. Both pairs of wings are fully developed, the hinder being always the smaller of the two, and having fewer nervures. These wings, when the insect is at rest, are separated, but are connected during flight by a series of tiny hooks, which run along the upper margin of the hinder pair, and fit into a groove upon the lower margin of the upper pair. These hooks vary considerably in form in different families, so much so, indeed, that an experienced entomologist can decide, by the examination of one of these organs alone, the group to which the insect possessing it belonged.

In the butterflies and moths the upper and lower wings are also connected during flight, but by one hook only, which is situated at the base of the hinder pair.

In all the Hymenoptera the female insect is furnished with a long, horny ovipositor, which in many species serves also as a weapon, communicating with a gland wherein poison is secreted. This structure, however, is found in the "gentler" sex only, the male being absolutely harmless.

The pupa, in the insects belonging to this order, is invariably quiescent, as is also the larva, excepting in the one family of the *Tenthredinidæ*, or Saw-flies. This group forms a curious exception to the general rule, the larvæ being not only active, but being furnished with legs, whereas in the remaining group they are entirely without limbs.

The life-history of the Ichneumon-flies is of a most singular and interesting character, for they pass their larval, and frequently their pupal existence also, within the bodies of other insects, generally while in the grub stage of their development, upon the flesh of which they feed, and which sooner or later succumb to their attacks. Hence it is that they have received the title of "Ichneumon" flies, for they behave in much the same manner towards those insects upon which they are parasitic as, according to popular rumour, did the little animal after which they are named towards the crocodile.

It is a curious fact that, taught by some wonderful instinct, the ichneumon-flies invariably leave untouched the vital organs of their involuntary host, confining their attacks to the masses of fat which occupy so large a proportion of the body of a caterpillar. It is also most singular that the insect at whose expense they are living seems but little troubled by their presence, and continues to feed as freely as if no internal parasites were gradually eating away its very life.

The vitality of the doomed insect, however, almost invariably endures only to the period at which, in the natural course of events, it would have passed into the pupal stage of its development, and it is but very seldom that it retains sufficient strength to enter upon that period of its existence. In the few cases, however, in which the transformation is completed, death almost instantly supervenes, the whole of the internal organs having been devoured by the insatiable little parasites within.

In some cases these become pupæ within the empty skin of their late victim, while in others they issue forth and construct their cocoons in the nearest convenient situation. But in no case does their parasitic existence appear to terminate until the internal organs of their host are entirely consumed, a mere empty skin being left when they make their entrance into the outer world.

With some species of ichneumon a single grub inhabits the body of each caterpillar; in others a large number, varying, perhaps, from three or four to a thousand or more, combine in their attacks upon the unfortunate insect. But in either case the result is the same, the food consumed by the victim serving only to nourish the parasite, which, like the fungoid growth upon a tree, waxes strong at the expense of its host, whose death it is certain, sooner or later, to bring about.

These ichneumon-flies exercise a constant check upon the increase of various insects, and are in many cases themselves kept within due bounds by hyper-parasites, which by some wonderful perception detect at once a "stung" caterpillar, and deposit their eggs within the body of the internal destroyer. The larvæ produced from the eggs are again liable to the attacks of similar foes, whose offspring in turn suffer in like manner. These secondary intruders are scientifically termed "Hyper-parasites."

How far this persecution extends we cannot pretend to determine, but it is at any rate certain that we have detected the hyper-parasite of a hyper-parasite, and analogy would lead us to conclude that the process may be indefinitely carried on. In such a case the condition of a stung caterpillar would remind one of those "nested" Japanese boxes, which are packed away one within another till the innermost is nearly microscopic in dimensions.

Of ichneumon-flies attacking the aphis many species are known to exist, of which we will select two or three of the more prominent to serve as types of the whole. The operations of one of these, belonging to the genus *Allotria*, have been very well described by Mr. G. B. Buckton in his "Monograph of British Aphides," from which the following extract is taken :—

"In June, during the hot weather, I have seen as many as three of these flies upon one rose-sprig, each poised on the back of an aphis, which throws itself into many contortions for the purpose of throwing off its enemy. The ichneumon, however, remains fixed on the back for ten or more minutes before the ovipositor is thrust inside the skin of the victim and the egg is laid. The aphis appears to suffer at first but little, since it soon resumes its occupation of pumping up the sap.

"A worm-like, or else more commonly a maggot-like creature, according to the species of the parasite, hatches from the egg, and revels in the nutritious fluid elaborated by the aphis. The greater part of the abdomen is occupied by the maggot when it becomes full-fed, and then it may often be seen through the transparent integuments as a grub curled into a semi-circle. In the mean time the skin of the aphis becomes tense and shining, and then often shows a peculiar plated appearance, as if a number of angular horny plates were united to form the dome of the back.

"Finally, the aphis dies, the grub ceases to feed, and after a certain period of rest cuts out of the roof of its prison a circular plate, like a trap-door, as regular in form as if a carpenter's centre-bit had been used. The emerging fly has four wings, long antennæ composed of numerous joints, a wasp-like body and legs, and is in every way suited for its marauding expeditions."

At the season when the perfect flies appear the empty skins of the aphides from which they have emerged may be seen in numbers sticking to leaves and twigs, the circular holes through which the parasites made their way into the outer air affording conclusive evidence of the means by which they had perished. The abundance of these empty skins is sometimes beyond all belief, one half or even more of the entire colony seeming to have fallen victims to their winged foes. In one species of aphis, in particular, namely, that which feeds upon the cabbage (*Aphis brassicæ*), the proportion destroyed by ichneumons is sometimes far greater, for we are told that nine-tenths of the destructive little creatures are often infested by the parasite.

Another species, *Aphis rumicis*, which feeds upon the broad-bean, is greatly harassed by the persecutions of a minute ichneumon belonging to the genus *Aphidius*, a group of the *Chalcididæ*, which performs its work in a very curious manner. In the words of Mr. Buckton,—"This insect differs somewhat in its habits from other *Aphidii*, in that it undergoes its metamorphosis within a curious silken tent, which the larva constructs after it has become full-fed within the body of the aphis.

"The apterous, worm-like grub of this Chalcid perforates the hard aphis-shell at the belly, and then commences to spin a double-walled tent in the space comprised between the six legs of the insect. The floor of this tent is attached to the leaf on which the aphis originally fed, the web being carried up to its skin, which thus partially forms the roof. Subsequently the edge of the web is reflected downwards so as to form a chamber with double walls, a considerable space being found between them.

"In this cocoon the change into pupa takes place, and after an interval of about nine days the winged Chalcid cuts its way out of the silken envelope."

The aphis which attacks the wheat (*Siphonophora granaria*), again, is largely preyed upon by a little ichneumon-fly known as *Ephedrus plagiator*. As many as twenty aphides infested by the larva of this insect are often found upon one ear of wheat, and in more than one season the crops have been saved almost wholly by its labours.

Even in those ichneumons which deposit but one egg in the body of each aphis the small size of the perfect insect is very remarkable. But when we discover a species no less than twenty-four of whose grubs are often found within a single victim, we meet with some of the true dwarfs of the insect world; in fact, they bear much the same proportion to some of the larger species as does a cat to an elephant, or a wren to an ostrich, and it is truly wonderful that beings so minute should possess the power of performing tasks so important as those rendered to us by these little insects.

CONTENTING ourselves with merely a passing mention of the burrowing Hymenoptera belonging to the family of the *Crabronidæ*, which often provision their nests with aphides to serve as food for the future young, we will turn to the *Syrphi*, or Hoverer-flies, which form one of the group of the Diptera. These insects must be familiar to every one who has spent a day in the country during the summer months, for one can hardly avoid noticing them as they rest poised in mid-air, seemingly without the aid of exertion of any kind. In this position they will remain for many minutes, appearing to have no definite object in view,

Hoverer-fly (*Volucella*) magnified.

but to be thoroughly enjoying the sensation of hovering motionless in the air. At the slightest alarm they instantaneously vanish, darting away with such rapidity that the eye cannot follow their course, and reappearing with equal suddenness when they suppose the danger to have passed away. Even the swift-winged Hawk-moths themselves cannot compete in activity with the Hoverer-flies, which seem to travel through the air by means of simple volition, and to be perfectly independent of any ordinary means of propulsion.

While hovering, the motion of the wings is so wonderfully rapid that those organs are quite invisible, the insect appearing to be supported in the air in some manner unintelligible to human perceptions.

In the larval state of their development the hawk-flies are untiring foes of the aphides, being fully as voracious as the grub of the lacewing-fly before described. They are of a rather peculiar form, the tail being larger than the head, and the body unprovided with limbs, the necessary locomotion being performed by means of a number of tiny hooks with which the posterior segments are fringed. The sense of sight, too, is altogether wanting, the insect capturing its prey simply by means of its keen sense of touch.

After each forward motion the larva makes a slight pause, and moves its head rapidly to and fro in search of food, continuing to do so until it meets with an aphis. This is at once seized, and raised aloft into the air, where it is held until its juices are extracted.

As soon as this is the case the empty skin is cast aside, and its destroyer proceeds to search for another victim.

When full-fed, the larva suspends itself by the tail to a leaf or twig, and there hangs with the head downwards, entering upon the pupal condition without casting off its outer covering, which merely hardens and forms a kind of cocoon, just as is the case with that of the blow-fly before described. The form is now considerably changed, the head being far larger than the remainder of the body, which is greatly contracted, and the whole very much resembling in shape an ordinary hen's egg. The outer skin, which is of a hard, horny consistency, is crossed by numerous transverse bars, varying somewhat in number and form in the different species.

Just as is the case with the ladybirds, the abundance of the hawk-flies seems to depend chiefly upon the greater or less profusion of the aphides upon which they prey, an increase in the one leading to a corresponding multiplication of the numbers of the other. This was notably the case in the year 1869, when the aphis made its appearance in such vast numbers, for a large swarm of Hoverer-flies seemed to follow upon the steps of their victims, crossing even the sea itself rather than abandon their task. We find a notice in the *Entomologist*, vol. iv. page 357, in which the writer, Mr. C. Horne, says:—

"At Margate, on August 24, 1869, there came a great number of these insects, so as to attract the notice of all visitors. Many specimens were taken, among which I have identified *Syrphus balteatus*, *S. decorus*, *S. tæniatus*, and *S. topiarius*. The wind was then blowing from the east, and it was very hot weather. The pier at Ramsgate on the same day was almost covered with them, and every one said that they came from the Channel. After this the wind was from inland, but it was too fresh and breezy for many to remain; and they had become so scarce in the month of September, that with difficulty seven or eight specimens were procured.

"The servant at one of the houses in Clifton Terrace, Margate, says that she had to go to all the windows with a dust-pan and brush, to take them away from the window-ledges; and I have been given to understand that it was the same in most of the houses at the place. They went by strange names, but the most common one was that of 'horse-stingers,' from their appearance."

WITH so many ravenous foes constantly preying upon them it is little wonder that the numbers of the aphides, in spite of their extraordinary rate of increase, should be kept within due bounds, and it is impossible sufficiently to admire the manner in which the balance of nature is preserved, even among the smallest of her creations.

Neither is it possible to over-estimate the value of the services rendered to us by the aphis-parasites. Were their labours suspended but for a single year, vegetation would suffer an irremediable injury, for the hordes of the destroyers, checked only in slight measure by the action of wind and rain, would increase to so terrible a degree that the whole land would be insufficient to supply them with the requisite quantity of food.

Our corn, our fruits, our vegetables, our forest trees, all would disappear, the greater proportion killed outright by the incessant attacks of the ever-increasing myriads of their tiny foes, while the few that survived would probably sustain so great an injury that life would be retained but for a very short period of time. Famine would sweep through the land, thousands upon thousands of human beings would fall victims to starvation, and the country would sustain a blow to its prosperity that after-years might never altogether repair.

From such a calamity we are saved solely and entirely by the efforts of the group of insects of which a few typical forms have been briefly described in the foregoing pages—insects whose sole object in life is to keep down the numbers of creatures which exercise so prejudicial an effect upon vegetation, and whose duties are performed in so eminently perfect a manner.

We must therefore, I think, frankly acknowledge that these little beings go far to convince us of the error which we have committed of placing all insects under one category, and considering them as calculated only to cause injury to man and his interests, for they undoubtedly stand in a directly opposite position, taking rank as our benefactors, and not as our foes.

# CHAPTER XI.

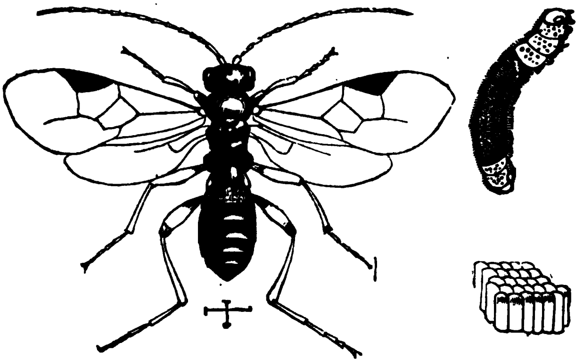
## PREDACIOUS INSECTS.

Ichneumon-flies again—How our cabbages are preserved—*Microgaster glomeratus*—Life history—Condition of a "stung" caterpillar—Cocoons of the Microgaster—The fruits of ignorance—Services rendered by *Microgaster*—The *Microgaster* in 1842—*Pteromalus brassicæ* and its work—The Empis and its prey—Its voracity—*Calosoma inquisitor*—Its beauty—Another species of *Calosoma*—Its valuable services—The Earwig as a beneficial insect.

As in the two preceding chapters we have considered some of the insects which, by preying upon the aphis, perform services of such vast value to mankind, we will now turn to others which, by keeping down the numbers of other, although, perhaps, less destructive beings, serve us in a similar manner. And we will begin with the little ichneumon-fly to whose agency we are annually indebted for the preservation of our cabbage crops, namely, the small black species known as *Microgaster glomeratus.*

This insect is parasitic upon the caterpillar of the Cabbage Butterfly (*Pieris brassicæ*), which has so justly earned the hatred of agriculturists by its ravages upon the plant from which it takes its name. A number of eggs are deposited beneath the skin of a single larva, as many as sixty or seventy grubs of the fly having sometimes been known to emerge from their victim at the completion of their growth.

As is the case with those species parasitic upon the aphis, the ichneumon-grubs carefully avoid the vital organs of their host, and confine themselves to the masses of fat stored up within its body, upon which it depends for nourishment during its pupal existence.



*Microgaster glomeratus*, with cocoons and section of cabbage caterpillar, showing parasitic larvæ *in situ.*

Just as a hibernating animal, or one which passes the winter in a state of torpor, accumulates fat for some months previously, in order that it may serve as nutriment when ordinary food cannot be obtained, so does a caterpillar lay up similar stores, which are gradually assimilated into the digestive system during the period of its pupal inactivity. In the case of a "stung" caterpillar, these supplies are consumed by the internal parasite, so that their victim, when the time comes round for it to enter upon the next stage of its development, is either unable to undergo its transformation, or else dies as soon as the change has taken place.

To all outward appearance, however, the insect remains in perfect health, no sign being visible of the ravages of the internal destroyer. As the masses of fat are consumed, the ichneumon grubs increase in size in a proportionate degree, so that the caterpillar appears as plump and healthy as though no attack had been made upon it. When the time arrives, however, for the parasites to emerge, a curious change takes place. The body collapses as completely as does a burst bladder, the skin loses its colour, and the insect dies, the interior having been entirely consumed by the terrible enemies, which often spin their cocoons around the corpse of their late victim.

These little yellow cocoons may be seen in great numbers upon the fences and walls in the neighbourhood of cabbages, and, unfortunately, as Mr. Westwood remarks, are often mistaken by ignorant persons for "caterpillars' eggs," and destroyed accordingly.

The services rendered to us by these flies are very considerable, as may be easily proved by the examination of a hundred or so of the cabbage-caterpillars, but a very small proportion of which will be found to have escaped their foe. The results of their labours, too, are very apparent; for, at any rate as far as the neighbourhood of the metropolis is concerned, the numbers of the butterfly have decreased very considerably within late years. I have been much struck by this diminution in numbers during the last six or seven seasons, having found that in many neighbourhoods where fifty or a hundred specimens might formerly have been seen in the course of an hour or so, scarcely a single example is now to be found. Indeed, two or three years since, when in want of a few specimens of the insect, I was unable to obtain them for nearly four months, during the whole of which time, although constantly upon the look-out for the insect, I met with only an occasional example.

Mr. W. S. Coleman, in his work upon the British butterflies, mentions an instance in which the *Microgaster* almost wholly destroyed the descendants of a large flock of cabbage butterflies which crossed to this country from the Continent.

"In 1842," he tells us, "a vast flight of white butterflies came over from the Continent to the coast about Dover, and, spreading inland from thence, did an immense amount of damage to the cabbage-gardens; but so effectually did the ichneumon-flies do their work that an exceedingly small proportion of the caterpillars resulting from this flock of immigrants went into the chrysalis state, nearly all perishing just before the period of change."

Here it would seem that the numbers of the parasite underwent an increase proportionate to the abundance of the invaders, just as has already been described in the case of the aphis and its natural foes. But for this law, indeed, our losses would often be excessive, for the increased numbers of the injurious insect, brought about during its season of unusual plenty, would completely neutralise the labours of the parasites during many preceding seasons in diminishing its abundance. As it is, however, the proportions are so nicely balanced that we can generally count upon the total destruction of the excessive numbers of any injurious species during the season in which it appears in unusual plenty, its progeny being very rarely increased in number in a corresponding degree. A second species of *Microgaster*, *M. alveolarius*, while closely resembling the preceding insect in many ways, is yet worthy of notice for the wonderfully neat and careful manner in which the cocoons are placed side by side.

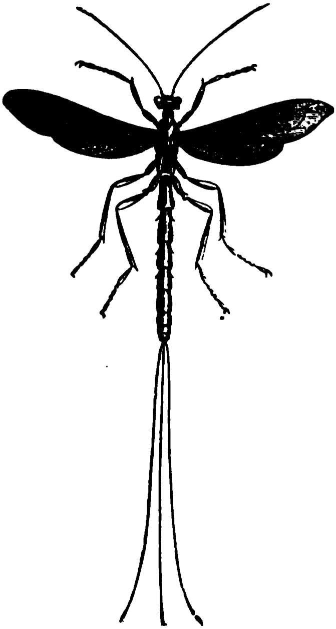
EVEN should the cabbage-caterpillar escape the *Microgaster*, and safely pass into the pupal stage of its development, it is by no means secure from the attacks of parasitic foes; for an equally small ichneumon-fly, known scientifically as *Pteromalus brassicæ*, deposits its eggs upon the chrysalis before the outer integument has become hardened by exposure to the air. The grubs, which average from two to three hundred in number, eat their way into the pupa as soon as they emerge from the egg, and speedily devour the whole of the internal organs, leaving behind them, when they emerge as perfect flies, nothing but a mere empty shell riddled with countless holes.

The perfect butterfly is largely preyed upon by wasps, while even its eggs are subject to the attacks of parasites, an extremely minute ichneumon-fly, *Teleas elatior*, selecting them as suitable abodes for its future progeny. So in all the four stages of its existence the cabbage-butterfly finds itself surrounded by foes, which perform their work in so effectual a manner that scarcely one of these insects out of a hundred ever attains to its perfect form.

Another highly injurious insect, namely, the Gooseberry, Currant, or Magpie Moth, as it is indifferently termed, (*Abraxas grossulariata*), is preyed upon by several species of ichneumons, which serve to keep its numbers within moderate limits. This multiplication of its foes is the more useful that the larva of the moth is seldom or never devoured by insectivorous birds, &c., seeming to possess some flavour which is distasteful to these, its otherwise natural enemies.

Ichneumon-fly (*Ophion sp.*).

As the life-history of the various ichneumons is of much the same character in all the species, we will not occupy our space with further details of these insects, but will pass on to a species of fly upon whose efforts the preservation of our oak-forests largely depends. This is one of the Diptera, or two-winged flies, and is known by the title of *Empis tessellata.*



An Ichneumon-fly (*Pimpla sp.*), magnified.

Any of my readers who have walked in the woods during the early summer must have noticed considerable numbers of a small green moth, which fluttered in dozens from the branches of every oak-tree at the slightest cause of alarm. This insect is the Oak-Moth (*Tortrix viridana*), which, in the larval stage of its development, feeds upon the leaves of the oak, rolling them up in order to form a kind of habitation in which it might elude the keen eyes of the insect-eating birds, and often causing very serious damage by its attacks. Upon this pretty but destructive little moth the *Empis* feeds, and does so in a very peculiar manner.

As soon as it catches sight of a victim it starts off in pursuit, and is sure, before very long, by means of its superior swiftness and agility, to overtake its quarry. The moth is then grasped tightly by the long legs of the fly, which does not consider it necessary to check its flight in order to feast upon its prey, but does so in mid-air, sucking the juices of its victim by means of its long and sharply-pointed proboscis. No sooner is one victim disposed off than it is thrown aside, a second being tolerably sure to take its place before many minutes are over.

But for the existence of this fly it is probable that our oak forests would ere long completely disappear. Each of the larvæ of the moth consumes three or even four oak-leaves before its growth is completed, whole trees being often entirely stripped of their foliage and serious injury inflicted upon them.

Notwithstanding the labours of the fly, it often happens that large tracts of forest present a blighted and withered appearance, their curled and shrivelled leaves bearing witness to the nature of the destroying agency. But, injurious as it is even now, it would be so to a far greater degree were its increase unchecked by the *Empis;* and it is scarcely an exaggeration to state that, but for this fly, the oak-tree in England would in the course of a few years only be ranked as a thing of the past.

BESIDES the oak-moth, there are a number of other moths whose larvæ feed upon the leaves of the same tree, and these are in some years so plentiful as to inflict very severe damage upon the oaks. In man parts of the country, however, these insects are largely kept in check by one of the Ground Beetles (*Calosoma inquisitor*), which ascends the trees in search of its victims, and destroys them in great numbers.

This is a very handsome insect, although its colours are not particularly striking, the head, thorax, and elytra being of an uniform dark bronze-green, the former finely granulated, and the latter decorated with closely-punctured striæ. The edges of the thorax and elytra are of a brilliant blue-green hue, which also extends to the lower surface of the body. The insect is about one inch in total length.

*Calosoma.*

This is not an universally common species, being rather local, but is generally to be found in tolerable abundance in those neighbourhoods in which it occurs. The Forest of Dean is a well-known locality, and there, as I am told by the Rev. A. E. Hodgson, who has enjoyed abundant opportunities of observing its habits, the beetle exercises a very palpable check upon the increase of the oak-feeding larvæ. In this task it is assisted by another beetle, *Silpha quadripunctata*, which has already been mentioned in connexion with the insects acting as scavengers.

A second species of *Calosoma*, namely, *C. sycophanta*, is only occasionally found in this country, and can scarcely take rank as an indigenous species. It is, however, very abundant in some parts of the

Metamorphoses of *Silpha quadripunctata.*

Continent, where it performs services of the highest value to mankind. The pine-forests, upon which we are largely dependent for our supply of timber, there suffer very greatly from the ravages of certain larvæ, those of two species of moths and of a certain saw-fly being the most destructive. These in some seasons appear in great numbers, and literally strip the trees of their leaves, travelling onwards in vast multitudes, and leaving nothing but desolation behind them.

Now, it must be remembered that the members of the fir group differ in a very important particular from other trees, inasmuch as, if denuded of their foliage, they are unable to sustain the injury, and straightway die. The assistance of the Calosoma is, therefore, of the more value, for both the perfect beetle and its larva feed upon these destructive caterpillars, and devour them in such numbers that we shall not be guilty of exaggeration in stating that, but for the exertions of this single beetle, the largest pine-forest would, in the course of a few short years, be reduced to a mere mass of dead and withered stems.

This is a far more handsome insect than the preceding, the head and thorax being of the deepest violet hue, while the wing-cases are of the most glorious metallic gold-green, over which various tints of blue and purple play with every change of light. A number of punctured striæ also run longitudinally along each elytron, while the thorax is finely granulated in much the same manner as that of *C. inquisitor.* Most of the specimens taken in this country have been found near the south-eastern coast, a fact giving rise to the supposition that it is not an indigenous species, but that it is occasionally blown over from the Continent.

In our own country the beetle is far too scarce to prove of any value; but, as it is occasionally found in Great Britain, and as it exercises a potent influence upon certain of our commercial interests, I have felt compelled to devote to it a few lines of description.

EVEN the earwig, injurious as it undoubtedly is in certain ways, yet sometimes performs services of considerable value. In the *Entomologist's Monthly Magazine*, vol. xix., page 88, is a communication in which some curious statements are made with regard to this insect, the writer, Mr. J. W. Douglas, having noticed that it preys upon the scale insects (*Cocci*), which are often so injurious to cultivated plants.

"I have on my red-currant bushes," he tells us, "some colonies of *Lecanium ribis*, which year after year increase and multiply, that is, in some years there are more absolutely than in others, and in one year they abound on one bush, and in one year they all but leave it and appear on another. I speak only of the females, for the male I have never been able to find in any stage of life. Their manner of life is in this wise: in the early spring (February or March) the eggs are hatched under the hibernated maternal shell, which was in the year previous fixed on the older branches, generally under the protection of loose bark, and, although the young ones soon come out from the cover, they remain close by, and for many weeks grow very slowly, remaining soft, shell-less, and of a dingy light brown colour. About the middle of May the shell becomes well defined on the growing or full-grown form, assuming a light brown colour, and having several dark brown streaks or shades, the shape being broad oval, slightly convex. Then they gradually become more convex, the discoidal wrinkles appear, the smooth central ridge more distinct, and the colour changes to deep, shining, sealing-wax red, which is maintained throughout the following winter.

"Up to the 15th of June this year (1882) the shells, growing and even full grown to the limit of the penultimate condition above mentioned, were numerous, but then almost all disappeared, and I was puzzled to account for their absence. But, looking closely one day at the end of June, I saw, at the place where a *Lecanium* had been a few days before, two young earwigs engaged in demolishing the last remains of the departed. It is, perhaps, hazardous to say in this case, '*Ex uno disce omnes*,' but I think it not at all improbable that among their capabilities the Forficulæ (earwigs) are coccivorous."

If such really be the case, as we seem to have good grounds for believing, we shall have cause for looking upon the earwig in a different light from that in which we have hitherto regarded it; and, although we cannot consider it as altogether beneficial, we may yet assign it a position among those insects which combine the properties of enemies with those of friends.

# CHAPTER XII.

## WOOD-BORING BEETLES AND THEIR ALLIES.

A seeming paradox—Why wood-destroying insects are not destructive—Nature of their work—The *Scolytus*—A scientific scare—Structure of the Scolytus—Its cylindrical form—Strength of its jaws—Life-history—Manner in which the eggs are laid—Radiating tunnels of the larvæ—Effect upon the bark—Emergence of the perfect beetles—Their appearance—The Death-watch—The Stag-beetle—Do wood-boring insects attack healthy trees?—Discrepancy in size between different specimens of the Stag-beetle—Distinctions between sexes—Power of jaws—Effects of decapitation—Uses of jaws—Duration of life of Stag-beetle—Life-history—The larva, or "Joe Bassett"—The pupal condition—Time of emergence of perfect beetle—The *Dorcus* and the *Sinodendron.*

THE statement that forests throughout the world owe their existence to wood-destroying beetles may at first sight seem paradoxical, but is none the less true, and, as we have already seen how certain trees are saved from destruction by the labours of insects, so we shall find that, but for the agency of the same beings, not even the smallest copse could exist for many years upon the earth.

In the first place, it is a well-known fact that, if a tree fall to the ground, and be left untouched in any way, the bark firstly, and afterwards the wood, will resist the action of the elements for a very long period of time, and the useless trunk will be left to cumber the ground, and prevent the growth of vegetation on the surface which it covers. Thus, if no other agents of decay, saving the rain and the atmosphere, existed, every forest must in course of time come to consist of a mere mass of prostrate trunks, for the period occupied in decay would be so great that no fresh trees could take the place of those which had fallen. From this calamity we are saved by the wood-boring beetles.

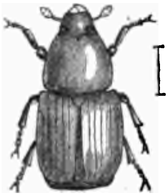
No sooner does a tree exhibit signs of failing health than these insects commence their attacks, perforating the bark, and driving their tunnels into the wood in all directions. Two consequences shortly ensue. The bark, loosened at multitudinous points of contact with the wood, falls away, thus greatly facilitating the operations of the elements; and, more important still, the burrows made by the beetles in the wood itself allow the rain and the atmosphere to gain access to the interior of the trunk, rapid decay thus setting in without loss of time.

As soon as this is the case, the manifold insects and kindred beings which find their home in semi-rotten wood, but which cannot attack it until decay has commenced, take up their quarters in the fallen trunk. These in turn daily extend their burrows, and finally reduce the fallen tree to a mere mass of dust, which not only leaves the ground free for future vegetation, but acts as a powerful manure to the trees which take its place.

It will be found, too, that in those parts of the world where vegetation is most luxuriant the wood-boring beetles are present in numbers correspondingly increased, in order that they may duly perform the work intrusted to them. Thus, in our own country, where the growth of timber is not very rapid, and where a tree, should it fall, is rarely allowed by man to encumber the ground for any length of time, these insects are not of large size, nor are they present in any great numbers. But in tropical lands, where vegetation reaches so wonderful a degree of luxuriance, their numbers and size are enormously increased. In many well-wooded districts, indeed, the greater proportion of the insect inhabitants belong to those groups the members of which find their food in decaying wood, families whose representatives in other lands are by far the more numerous being often conspicuous by their almost entire absence.

As regards the wood-boring beetles inhabiting Great Britain, by far the most widely-known is the species known as *Scolytus destructor*, a little insect which some years back created considerable excitement in scientific circles. It was then looked upon as the very Azrael of the vegetable world, and suggestion after suggestion was made as to methods of persecution which should bring about its utter extermination. It was even recommended that every tree which showed the slightest signs of its presence should be at once cut down and burnt, in order that, if possible, no specimen should be left alive in order to perpetuate its kind.

Had this programme been carried out, we may feel sure that far more harm than good would eventually have resulted; and, as we are now learning to regret our folly in persecuting the smaller birds, so in after-years we might have found cause to repent of our ill-advised extermination of the *Scolytus*.



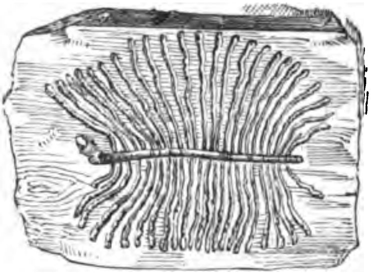
*Scolytus destructor.*

The most extravagant statements, too, were made with regard to its supposed ravages. Large avenues of elm-trees in all parts of the country were said to have been entirely stripped of their bark by the beetles, while it was even prognosticated that, unless the most severe remedial measures were immediately taken, no single elm would remain in the country in the course of a few years.

Time, however, has proved the contrary, and our elm avenues seem none the worse for the presence of the beetle. For, the insect appears never to attack a perfectly healthy tree, and, indeed, were it to do so, its larvæ would in all probability be quickly drowned by the flow of sap into their burrows. But, as soon as a tree shows signs of decay, the *Scolytus* commences its operations, and paves the way for other beings whose combined efforts shall reduce the now useless wood to profitable manure. And in so doing they are in no sense productive of harm. The tree, when once decay has set in, is of value no longer, and becomes a mere excrescence upon the land, useless in itself, and preventing by its presence the growth of other and more healthy vegetation. Any agency, then, which will not only remove it from the face of the earth, but will also transmute its fibres into sustenance for its successors, deserves our hearty approval, and in no wise deserves the abuse which is even now sometimes showered upon it by those who have not troubled to consider the subject in its different bearings. They see a withered and decaying tree; they strip it of its bark, and find the wood traversed by a number of burrows, inhabited by certain beetles and their grubs. Without further inquiry they consider these as the destroyers, thus condemning them without hearing the evidence for the defence.

These same individuals, were they to hear the burying-beetles accused of slaying the animals whose bodies they inter beneath the soil, would treat the suggestion with the scorn it deserves, although it is scarcely less absurd than the notion that the wood-boring beetles destroy the trees in which they are found. The two cases are of a precisely similar nature, both insects being the appointed agents for the performance of a beneficial task, and both being equally entitled to our respect and protection.

THE mere appearance of the Scolytus (*S. destructor*) is sufficient to inform us that it is in some way a burrowing insect, the cylindrical body and short legs bearing ample testimony to the fact. Unlike those insects which burrow into the soil, however, its chief strength lies in its jaws, which are wonderfully large and powerful for so small an insect.



**Fragment of elm bark showing tunnels of *Scolytus*.**

Aided by these weapons, the female beetle perforates the bark, and drives her tunnel beneath, just upon the surface of the wood itself. This done, she retraces her steps, and deposits a number of eggs at intervals along the burrow. This operation often so completely exhausts her strength that she dies without being able to emerge into the outer air, and her dead body acts as a barrier against the inroads of enemies.

*Scolytus* larva.

The young larvæ, as soon as they are hatched, begin to tunnel for themselves, each striking off at right angles from the burrow made by the perfect insect. At the outset these radiating tunnels are very small, but gradually increase in a degree corresponding to the growth of the grubs, until, when these are full fed, they are of sufficient diameter to allow of the passage of a No. 5 shot. As soon as their development is complete, each grub drills a hole through the bark, and emerges as a perfect beetle into the outer world.

In the course of a very short time the bark beneath which the insects had tunnelled, being loosened at so many points of contact with the wood, falls to the ground, and so exposes the trunk to the direct action of the rain and the atmosphere. Trees may often be seen the stems of which have been wholly stripped of their bark by the beetles, the radiating tunnels affording very evident signs of the agency which has been at work.

The perfect insects appear towards autumn, and may then generally be found plentifully in the neighbourhood of elm-trees. They may be easily recognised by their peculiar form, the thorax being very nearly as long as the elytra, while the extremity of the abdomen seems to be obliquely cut off, instead of being rounded, as is usually the case. The head and thorax are of a polished black colour, and are covered with a multitude of very fine punctures, which cannot be discerned without the assistance of a magnifying-glass. The elytra are of a dull-reddish brown hue, and are marked with a series of punctured striæ, the spaces between which are ornamented by irregular rows of smaller punctures. The insect is rather more than one-sixth of an inch in length.

Six species of *Scolytus* are known to inhabit Great Britain, of which the above-described is the only one generally found in any abundance. A number of allied insects, however, belong to the same group, and exhibit such diversity in the nature of their food that there is scarcely any tree which is not subject to the attacks of one or more species of these little beetles. In the accompanying illustration is represented one of the wood-boring beetles which attacks pine-trees (*Hylurgus piniperda*), and which is often found in the greatest profusion.

*Hylurgus piniperda.*

THE well-known Death-watch (*Anobium striatum*), too, which is still regarded with superstitious awe in many parts of the country, is another of the wood-boring beetles, although it belongs to a different group from that which includes the *Scolytus* among its members. This insect, unfortunately, is rather apt to get into houses and make considerable havoc in furniture and wood-work, causing it to assume the character generally described as "worm-eaten." The curious "ticking" sound, thought by so many to be a presage of impending death to some member of the household, is caused by the tapping of the hard head against the wood, and is probably intended by the insect as a signal to its mate.

*Anobium striatum*
and larva.

Destructive though it may be in our houses, however, it is not so when fulfilling its appointed task in the natural sphere of its operations, and assisting in the removal of decaying wood. Although less plentiful than the *Scolytus*, it is still of considerable service in this respect, and is therefore entitled to a place amongst our insect allies.

OUR largest British beetle, namely, the Stag-Beetle (*Lucanus cervus*), is also a wood-borer during the larval stage of its existence, and is generally considered as causing great damage to the trees upon whose wood it feeds. I scarcely think, however, that this can be the case, and am much inclined to believe that no wood-boring beetle ever attacks a perfectly healthy tree, those only being selected which are already weakened by disease. For, were this not the case, it is scarcely probable that forty or fifty beetles should select the selfsame tree as the scene of their operations, the fact that they do so showing that it must possess some particular quality not found in the neighbouring and apparently equally suitable trunks.

It is more than probable, however, that the stag-beetle accelerates the death of such trees by the tunnels with which it perforates the wood. In such cases, however, it is only anticipating the inevitable, and performs a beneficial act in removing the unhealthy timber in order that fresh vegetation may take its place.

The stag-beetle is a curiously local insect, being found abundantly in many parts of the country, while in others not a single example has ever been found. The line of demarcation which separates these districts is often a very slight one, a distance of only two or three miles sometimes dividing a neighbourhood where the insect is plentiful from another where it is never seen.

The discrepancy in size between different specimens of this insect is very remarkable. A well-developed male, from the extremity of the body to the tip of the mandibles, will often measure three inches in length, while another, perhaps, will scarcely

Stag-Beetle (male).

exceed one-third of these dimensions. It is thought that this variability in size may be in some way connected with the nature of the food supply, and that those grubs which from some cause or other have subsisted upon insufficient nourishment produce the dwarfed specimens which are occasionally found.

The male insect may be at once distinguished by the superior size of his mandibles, which often obtain a length of three-quarters of an inch. Formidable as these weapons appear, however, with their sharply toothed edges, they are in reality far less so than those of the female, which, in spite of their small size, can inflict a wonderfully severe pinch.

It is a curious fact, as mentioned by Mr. Curtis, that these jaws retain their muscular power for a considerable time after the head has been separated from the body. He tells us, indeed, that upon one occasion the head of a stag-beetle, severed during the evening, still possessed sufficient power to pinch his finger when examined upon the following morning.

It does not appear that these jaws are principally intended to serve as weapons of offence, their true use seeming to lie in wounding twigs and shoots in order that the beetle may obtain the vegetable juices upon which it feeds. In confinement the beetle takes very kindly to a diet of sugar moistened with water, licking it into the mouth by means of the tufted yellow tongue which may be seen lying between the *palpi*, or feelers.

The life of the stag-beetle extends over a considerable period of time, the larval existence alone occupying no less than four years.

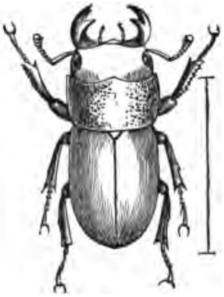
The larva, or "Joe Bassett," as it is termed in some parts of the country, is a large and awkward creature, perfectly helpless when removed from its burrow, and quite incapable of locomotion upon a level surface. When full fed the grub constructs for itself a kind of cocoon, formed principally of chips of wood, and therein undergoes its change to the pupal condition.

It is a somewhat remarkable fact that its last transformation takes place some months before it makes its appearance in the outer world, for specimens are frequently found in a perfectly developed condition as early as the beginning of the year, while the insect is never seen at large until the month of June. I have had living specimens in my own possession as early as the first week in February, the only difference between these examples and those found later on in the year being that they were generally in a semi-torpid state, a condition probably induced by the low temperature.

If the season be a warm one, the stag-beetles usually appear during the first or second week in June, and may then be seen clinging to fences, tree-trunks, &c., during the day, or flying in their peculiarly heavy and clumsy manner towards dusk. To capture one of these flying specimens is a wonderfully simple task, all that is required being to hurl a stick so as to pass within a foot or so of the insect. If this be done the beetle, although not struck by the missile, will almost invariably descend to the ground, appearing to be so bewildered by its novel experience that it loses for the time all command over its wings.

A CLOSELY-RELATED species, namely, the beetle known by the somewhat lengthy appellation of *Dorcus parallelopipedus*, is also a wood-boring insect while in its larval condition, although its smaller dimensions render its operations of less importance than those of the stag-beetle. This is a far less plentiful species than the preceding, and is seldom noticed except by those who are specially looking for it.

The largest specimens of the *Dorcus* are about an inch in length, the females being usually rather smaller than the males. The colour of the insect is an uniform dull black, the only exception to which is a narrow band of golden down which borders the posterior margin of the head.



*Dorcus parallelopipedus.*

The thorax of the *Dorcus* is singularly large, being wider than either the head or the elytra. This superior size is clearly intended to allow space for the powerful muscles which work the fore-legs, those limbs being employed by the insect in forming the burrows in which the eggs are to be deposited.

AN allied beetle, the *Sinodendron cylindricum*, is remarkable for the wonderful numbers in which it is sometimes found in decaying wood. In some cases. the trunk is literally honeycombed by its burrows, beetles, larvæ, and pupæ being found together in such abundance that their combined numbers would sorely tax the capacities of an ordinary pail, were their discoverer to wish to carry away his captures *en masse.*

# CHAPTER XIII.

## WOOD-BORING BEETLES AND THEIR ALLIES (*continued*).

Longicorn Beetles—The *Rhagium* and its life-history—The Musk-Beetle—Its powerful odour—The musk-beetle and the microscope—Variability of colour—Wireworms—Not invariably inimical—Structure of Skipjack Beetles—Their power of leaping—*Melanotus rufipes*—*Campylus linearis*—The Goat-Moth—Its size and appearance—Early existence of the goat-moth—Strength of the caterpillar—Its powerful odour—Pupal existence—Appearance of the imago—"Grease" in the cabinet—The Sirex—Its forbidding appearance—The ovipositor and method of using it—Life-history—The Clothes-Moth and its work—A warning to housewives.

THEN there are the various Longicorn beetles, which, although not very numerous in this country, are found in vast numbers and variety in all tropical regions where large tracts of land are occupied by virgin forest. Some of these, like the stag-beetle, feed upon living as well as decaying wood, although it would appear, as with the preceding insects, that thoroughly healthy trees are passed by in favour of those in a weakened and diseased condition, while others never attack any but semi-rotten trunks.

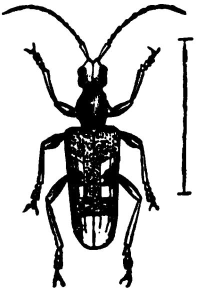
Of our British species we can describe two only as types of the remainder, and will select as our first example the beetle known as *Rhagium bifasciatum*, an insect which bears no popular title, and which is to be found in decaying pine-stumps. This is a rather handsome insect, the ground colour being a greenish-black, while head, thorax, and elytra are covered with a short golden down. Upon either wing-case are two yellow marks, extending from the side margin nearly to the suture, and slanting obliquely towards the tail. These marks are placed almost equi-distant from the base and apex of the elytra and from each other, thus dividing the wing-cases into three tolerably equal portions.

The antennæ and the greater portion of the legs are reddish brown, the apical half of the thighs alone being black. From either side of the thorax proceeds a sharp spine, the use of which, if there be one, has never as yet been discovered. The insect averages about three-quarters of an inch in length.

The larva of this beetle is remarkable for the curious cocoon which it constructs when it is full-fed, and in which it passes its pupal existence. This nest, if we may so call it, is composed of fragments of wood, formed by the insect into a kind of oval cell, in which it lies quiescent until its final transformation takes place. These cocoons, unfortunately, are exceedingly fragile, and it is by no means easy to extract one uninjured from the stump in which it has been formed.

A second species of *Rhagium*, known as *R. in-*

*quisitor*, affects willow and birch-trees, and is represented in the accompanying woodcut.



*Rhagium inquisitor.*

THE Musk-Beetle (*Aromia moschata*) is perhaps more generally known than the preceding insect, the conspicuous odour with which it is endowed, and which has earned for it both its popular and scientific titles, often calling attention to its presence when it would otherwise escape detection.

It is a handsome insect, more especially beneath the microscope, when its green wing-cases seem literally to become one glowing mass of gems, the tints of which are perfectly indescribable in their richness and variety. There are, indeed, few more glorious objects in nature, when viewed in such a manner, than the elytra of the musk-beetle, which, in their resplendent brilliancy as far surpass all human handiwork as the sunlight excels our most gorgeous illuminations.

Although the ground colour of the musk-beetle is generally a vivid green, considerable variability may be noticed in this respect when comparing specimens of the insect. It is a curious fact, too, that the colouring seems to vary greatly in different localities, examples from one district being of a green hue, while others from another neighbourhood, perhaps not many miles distant, will be of a uniform bluish, or in some cases, even, of a coppery, tint.

The size of the insect, too, varies to a very great extent, some specimens being fully twice as large as others. This is probably due, as with the stag-beetle, to some peculiarity in the diet of the larva, the smaller specimens having during that stage of their development been compelled to exist either upon insufficient, or else upon unsuitable food.

The musk-beetle is generally plentiful wherever willow-trees abound, the perfect insect usually making its appearance towards the middle of August. At this time it may be found either clinging to the trunk of the tree from which it has lately emerged, or else sunning itself upon the leaves. Sometimes quite a number of the insect may be taken in company, and I well remember finding some ten or fifteen specimens upon a small pollard willow barely a foot in total height.

Rather earlier in the year the insect may be found in various stages of its development by splitting up the trunks in which it is feeding. Grubs, pupæ, and perfect insects may then be seen together, the latter, which have but just undergone their final transformation, resting quietly in their burrows until their outer integument shall have been sufficiently hardened by the action of the atmosphere to enable them to make their entrance into the outer world.

It has sometimes been doubted whether or not the musk-beetle is or is not destructive to the trees upon whose wood it feeds. Some observers take one, and some the other side of the question, both being equally positive that their theory is the correct one. As, however, the insect is seldom, if ever, known to attack any but old trees, it is doubtful whether it plays any part in their destruction, and we may safely infer that at most it but anticipates by a few years the inevitable action of time.

And in this its action cannot be considered as harmful, for it seems an universal law of nature that none of its creatures, animal or vegetable, shall ever be allowed to die of old age. The competition is so keen, and the struggle for existence so fierce, that whenever an animal or plant shows signs of incipient weakness or decay its place is at once occupied by beings stronger and more fitted for a position in the world than itself. Such being the case, the musk-beetle is but carrying this law into effect when it attacks the willow-trees, for, by removing those which are gradually failing in strength, it clears the way for others which are to succeed them, thus performing not an injurious, but a beneficial task.

It has already been mentioned, with regard to the *Scolytus*, that popular opinion, which was once so strongly against it, gradually veered round in its favour, until men realised the fact that, instead of being their foe, it was in reality their ally. And as with this, so it is with others, which are even now regarded as injurious beings, but which are, nevertheless, productive of nothing but good both to ourselves and to our interests. Indeed, it is scarcely saying too much if we prophecy that in all probability the lapse of time and the progress of scientific discovery will gradually bring home to us the fact that, not only is there no being upon earth which is altogether inimical to us, but that there is none which is not, in some way or other, capable of benefiting us if we but understand how to take advantage of its services. In the investigation how this may most speedily be brought about lies the true object of scientific research, the study of classification, in which so many naturalists wholly occupy themselves, being only of subsidiary importance.

THERE must be but few of my readers who are not aware that the so-called "Wireworms," or larvæ of the Skipjack-Beetles, are among the most terrible pests with which the agriculturist has to contend, his crops sustaining incalculable damage year after year from the ravages of these creatures, which, preying upon the roots and not the foliage of their food-plants, are consequently with difficulty discovered and destroyed.

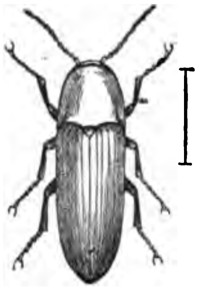
Wireworm.

But we must not suppose, because certain members of this family of insects exert an injurious influence upon our interests, that therefore the entire group occupy a similar position. On the contrary, many of the skipjack-beetles are well entitled to a position among our insect friends, for they feed, not upon the roots of our crops, but upon dead and decaying timber.

If we examine any of the semi-rotten stumps to be found in every wood, we are almost sure to find that a large proportion of the tenants are skipjack-beetles in their various stages of development, egg, grub, pupa, and perfect beetle being often found within a few inches of one another. Sometimes a large quantity of specimens will be found together; in other cases two or three stragglers only may be discovered. But in either case the insects are present for a beneficial purpose, transmuting death into life, clearing the ground of useless and decaying matter, and preparing the soil for the growth of fresh and healthy vegetation.

All the skipjack-beetles are very similar in general form, although they vary considerably in colour and size. Their principal characteristic, and that from which they derive their name, is found in the remarkable development of the lower surface of the thorax, which endows them with the power of leaping into the air should they find themselves upon the ground in a reversed position.

This development consists of a long, elastic spine, scientifically termed the "mucro," which proceeds from the prosternum, or lower portion of the prothorax, passes between the bases of the fore-legs, and fits loosely into a cavity between the central pair. When the insect happens to fall upon its back on a level surface it arches the body backwards until it rests merely upon the head and the extremity of the abdomen, the mucro being by this movement drawn from the groove in which it lies while the insect is at rest. Suddenly, the beetle reverses its position and the mucro flies into its place, driving the base of the elytra with so much force against the ground that the insect is jerked for several inches into the air with a sharp "clicking" sound, which has earned for the family the popular title of "Click-Beetle." As it rises from the ground it gives a half-turn of the body, and generally contrives to regain its feet upon its descent. Should it fail in doing so the process is repeated, and so on until the desired result is attained.



Skipjack Beetle
(*Elater*).

By placing one of these beetles upon a plate, a sheet of glass, or other smooth and polished surface, this process may be easily watched, the insect being unable to retain its foothold upon its descent, and therefore repeating its performance until sheer weariness causes it to desist. By holding the beetle between the finger and thumb, too, an idea may be gained of the wonderful muscular force exerted by the insect during its leap.

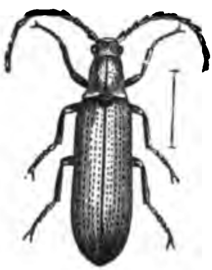
The object of this curious leaping property may be easily discovered upon noting the form of the body; for it will be seen that the shape is so convex, and the legs so short, that the insect, which usually feigns death and falls to the ground at the first sign of danger, would be quite unable to regain its foothold by any ordinary means should it happen to fall upon its back. This it appears to do in almost every case, so that its leaping faculties are brought into constant requisition.

The group of beetles to which the skipjacks belong is a large one, numbering in all some sixty British species. Many of these are rarities, but others are universally plentiful, and may be seen in numbers upon any warm day in spring or summer as they bask in the sunshine upon almost every plant and flower. A tolerably abundant species, and one whose operations are of a strictly beneficial character, is the long black insect scientifically known as *Melanotus rufipes*, but which does not possess a popular title.

This is one of the larger species, averaging from half to three-quarters of an inch in length. The colour is of an uniform pitchy brown, except as regards the legs and antennæ, which are of a dull brownish red.

During the summer months this beetle is by no means uncommonly to be found, resting upon various plants, or flying heavily in the sunshine. Earlier in the year it is to be taken in decaying stumps, logs, &c., and specimens may generally be found, even upon the coldest days of winter, by the aid of a mallet and chisel.

Another of the skipjack-beetles which finds its food in decaying wood is the handsome species known as *Campylus linearis*, which, although less abundant than the preceding insect, is nevertheless by no means uncommon. In many respects it differs considerably from its fellows, the head, for instance, standing boldly out from the thorax, and the eyes being large and prominent. The colouring is somewhat variable, but may be briefly described as follows :—



*Campyl us linearis.*

The head and antennæ are black, the forehead, however, as well as the various organs of the mouth, being generally reddish. The thorax is red, as are also the elytra in the male insect, those of the female being brownish-black, with a yellow side border. The legs are generally black, with the exception of the knees and the tibiæ, which are yellowish-red.

This description applies to the more common form only. Specimens are often taken which vary very considerably from the ordinary type, an example now before me being of an uniform yellowish-red colour, head, legs, and elytra alike bearing the same unusual hue. This, of course, is a male specimen, the wing-cases of even the most aberrant female being always more or less suffused with brownish-black.

The *Campylus* is generally to be met with in the neighbourhood of decaying wood, and may often be found lying concealed in rotten stumps in the early part of the year, before the time comes round for it to make its appearance in the outer world. It does not invariably select such stumps for its habitation, however, decaying logs being equally to its taste; while only a few days before writing these lines I captured a specimen lying beneath the bark of a small stick, drawn at random from an ordinary faggot which had been suffered to lie neglected for some three or four years.

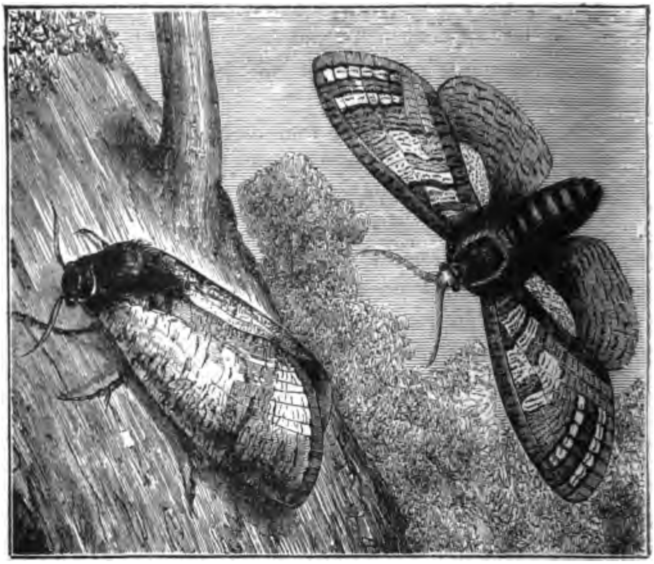
Many other of the skipjack-beetles find their food in similar substances, but, as their habits are all of much the same character, it will be unnecessary to separately describe them.

It is a remarkable fact that included in a single family of beetles we have so many which, by their ravages upon our crops, are inimical to us, while the remainder, by their services in the removal of decaying timber, are as certainly beneficial. Of our British species, I do not think that any has been found to occupy a neutral position with regard to ourselves : each is either our friend or our foe. With the increase of scientific knowledge, however, it is more than likely that those of the latter class will rapidly diminish in number; and it may be that even the most destructive species will be found to possess some qualities which may render them of use to us.

THE wood-boring insects are by no means represented by beetles alone, for we have many moths and several hymenopterous flies whose larvæ dwell within the stems of trees.

As a type of the former class we will take the Goat-Moth (*Cossus ligniperda*), an insect which, in spite of its abundance, is very seldom seen excepting by those who institute a special search for it. This fact is due partly to its retiring habits, and partly to its practice of appearing upon the wing only when darkness has set in.

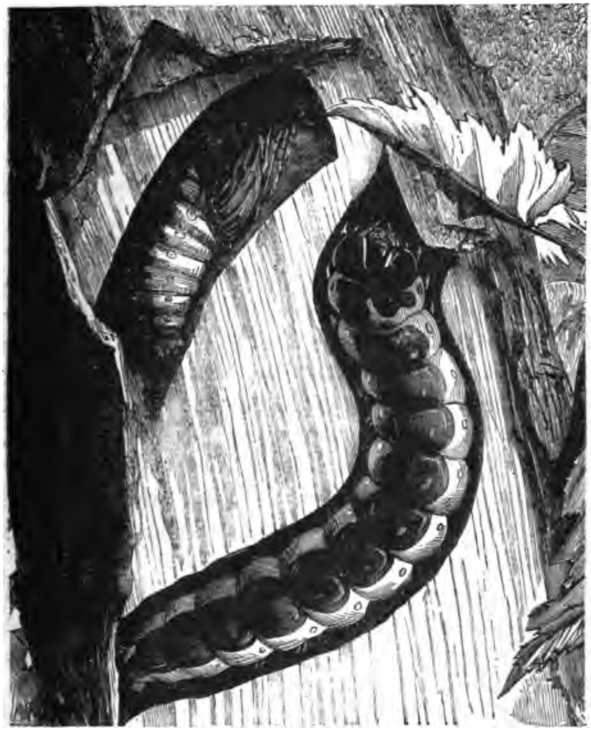
This moth is one of our larger species, a full-sized specimen measuring at least three and a half inches



Goat-Moth (*Cossus ligniperda*).

in spread of wing. It is rather a handsome insect, the wings being of a rich brownish-grey hue, diversified by numerous transverse streaks of a darker colour, which become more numerous towards the outer margin. The antennæ are slightly feathered, and the body is rather bulky in comparison with the size of the insect.

The earlier stages of the existence of the goat-moth, which extend over a period of no less than four years, are passed within the solid wood of various trees, willow, elm, and oak being those usually selected. During almost the whole of this time the larva is engaged in tunnelling backwards and forwards



Larva of Goat-Moth.

through the wood, and that to so great an extent that a tree-trunk may often be found perfectly honeycombed by the agency of quite a small number of these caterpillars.

In order to allow the larva to tear away and devour the woody fibres, it is furnished with jaws of such marvellous power that sheet-lead is cut away by them without apparent difficulty. This fact, I believe, was first observed by the late Professor Henslow, and was recorded by him in a communication to the *Zoologist*, vol. viii., p. 2,897.

"I placed half a dozen caterpillars of the goat-moth," he tells us, "in a glass jar with sawdust and a piece of willow, and covered the mouth with sheet-lead, which was perforated with an awl to admit the air. Three of the caterpillars were to-day crawling upon the floor; and, on examining the jar, I found they had effected their escape by gnawing the lead, having enlarged two of the perforations sufficiently to enable them to pass out of their prison. I have replaced the lead with wire gauze, which I expect will puzzle them."

Even so strong a material as perforated zinc is not always sufficient to withstand the jaws of these powerful larvæ, which have been known to take advantage of a slight crack, and to force a passage for themselves by bending back the metal by sheer muscular force. Nor is this marvellous strength confined to the head alone, for if one of these caterpillars be imprisoned beneath a glass tumbler, weighted by two or even three pounds of lead, it is almost certain to escape before very long, lifting the tumbler in the first place by means of the jaws, and working its way out by slow degrees, notwithstanding the pressure of the sharp edge of the glass upon its body.

In order to allow the caterpillar to perform such a feat it is evident that the outer integument must be remarkably strong and tough. And this we find to be the case in a very marked degree, more especially as regards the mahogany coloured skin of the back, which is in fact of an almost horny consistency.

This larva is distinguished by the possession of a most powerful and penetrating odour, not unlike that of the male goat, which has earned for the insect its popular title.

When full-fed the larva constructs a cocoon of wood-chips, in which it lies quiescent for some little time, but without changing to the pupal condition. At length, however, it exudes the contents of two sacs within the body, and so softens the silk by which the chips forming the cocoon are bound together that it can be easily broken. It then assumes the pupal form, and, after waiting until the integuments have become sufficiently hardened, works its way along its burrow until it lies within a very short distance of the mouth.

As the insect is not furnished with limbs during this period of its existence, it may not at first sight be easy to detect the manner in which it passes along its tunnels as is here described. A closer examination of the outer structure, however, will at once clear up the mystery, for it will be seen that the segments are fringed with a series of tiny hooks with their points directed backwards. Aided by these the pupa, by means of the alternate expansion and contraction of its body, can travel through the burrow with some little speed.

When the time approaches for it to undergo its final transformation, the pupa makes a further effort, and protrudes its body from the opening of the tunnel, until merely the hinder segments remain within the tree. The skin then splits, and the moth upon emerging finds itself in the most favourable position for gaining the trunk of the tree in order to dry its wings. Were the pupa to remain within the burrow, however, it could not do so without considerable difficulty, and, even were it to succeed, would probably injure itself very seriously in its passage to the outer air.

Upon examination of the trunks of willow-trees, and especially of those of the more aged, towards the end of June, several of the empty pupa cases are almost certain to be found protruding from the burrows of their late inhabitants.

In common with all moths whose larvæ feed within the twigs, stems, or roots of their food-plant, the goat-moth is very liable to become "greasy" when preserved for the cabinet, an oily liquid proceeding from the body and gradually spreading over the whole of the wings, completely destroying the appearance and value of the specimen. It will consequently be found advisable to remove the contents of the abdomen before "setting" the insect, and to replace them by cotton-wool slightly anointed with benzole.

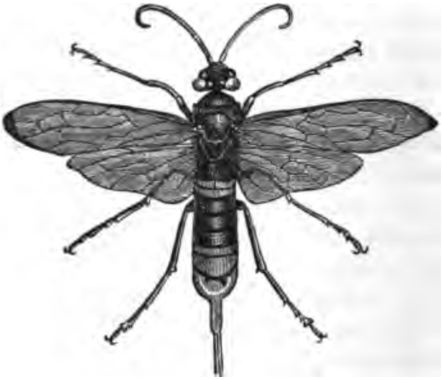
It is still doubtful whether or not the goat-moth ever attacks a perfectly healthy tree, or whether it selects those only which are more or less affected by disease. As is the case with the musk-beetle, however, the latter theory seems the more likely to be correct; and we may, at all events, safely assume that, if the insect does attack healthy timber, its doing so is the exception and not the rule.

As an example of the hymenopterous wood-borers we will take the large hornet-like fly, scientifically known as *Sirex gigas*, which belongs to the group of insects popularly entitled Saw-flies. In this species, however, the saws are modified into a long and powerful boring weapon, by means of which the insect can perforate holes in the trunks of the trees which it attacks, in order to deposit its eggs therein.

This ovipositor generally averages about three-quarters of an inch in length, and, in conjunction with the hornet-like body, presents so formidable an appearance that few, excepting those thoroughly familiar with the harmless nature of the insect, would care to meddle with so dangerous-looking a creature. The sting-like ovipositor, however, serves its legitimate purpose only, and cannot be used as a weapon of offence.

As is invariably the case, this ovipositor is of a compound structure, being formed of three separate parts. Two of these unite and form a kind of sheath, in order to protect the third, or boring instrument itself.

The earlier stages of the development of the *Sirex* are passed within the wood of fir-trees, the parent insect depositing her eggs deeply beneath the bark, so that the grubs find themselves surrounded by food immediately upon emerging. In some cases, where several of these insects have selected the same tree for the deposition of their eggs, the wood is found to be literally riddled with the burrows of the larvæ, sometimes a thin partition only existing between the different tunnels. Some considerable time always elapses before the development is complete, and it often happens that specimens of the perfect insect emerge from boarding, &c., which has been in use



*Sirex gigas.*

perhaps for many months, the grubs or pupæ having escaped both notice and injury when the timber passed through the saw-mill.

Like most wood-boring insects, the *Sirex* varies very greatly in size, some specimens being fully double as large as others. Two species are known to inhabit this country, the second, *S. juvencus*, being also a pine-feeder, and being often found in company with its congener.

WITH this fly we must close our account of the wood-boring insects. We have already seen how our forest-trees are protected from the excessive depredations of certain caterpillars by the influence of other insects, and are thus saved from the wholesale destruction which would otherwise inevitably ensue. We have also seen how a tree, as soon as it exhibits the first premonitory symptoms of failing health, is immediately attacked by insects, whose task it is to reduce it to a condition in which it shall no longer encumber the ground which should be occupied by fresh vegetation, but become instead a useful manure to accelerate the growth of its successors. We have now to notice an insect whose efforts, although exercised in a different direction, are not one whit less useful than those of the previously described species, and which, notwithstanding the almost universal obloquy which it has incurred, has undoubtedly in a large measure saved our woods and forests from utter and complete annihilation. This insect is the common Clothes-Moth.

The manner in which it serves us is easily explained, for it lies in the removal of the nests of birds from the branches of trees after they have answered their purpose, and have been deserted by their late inmates.

In most cases, hair, in some form or other, enters largely into the composition of these nests, serving to bind together twigs and other objects which, but for the employment of some such medium, would be unable to resist for very long the action of wind and weather.

This hair, as is well-known, is entirely unaffected by the ordinary agencies by which nature brings about decay. The fiercest storms may beat upon it year after year, nay, century after century, without producing upon it the slightest appreciable effect. It may be buried beneath the ground for an indefinite period of time with a like result, as has been abundantly proved by the discovery in the ancient tombs of Egypt of tresses of hair, which, in spite of their long interment, still preserve their pristine strength and beauty.

Now, unless some means were found for the removal of this hair in the deserted nests of birds, the branches of every tree in the country must sooner or later be completely choked up by the constantly increasing masses of twigs, wool, moss, &c., which are continually being deposited upon them.

With one or two exceptions, no bird either uses the same nest in two successive seasons, or makes use of one built by a stranger, constructing for each consecutive brood of young a totally new domicile.

Even in these exceptional cases she almost invariably gives the nest a new lining. Therefore, a nest, when once utilised, would, in the absence of special means of removal, simply become an incumbrance upon the tree. Nest after nest would be added, until the accumulation of material prevented the putting forth of leaves, and so, by depriving the tree of its respiratory organs, brought it to an untimely end.

From this calamity we are saved by the labours of various insects, chief of which is the clothes-moth. The moth itself does not take an active share in the task, leaving that duty to its larvæ, which feed upon the hair contained in these nests, and so allow the twigs, &c. of which the fabric is composed to be dispersed by the action of the elements.

Thus, a nest very seldom remains in its position for more than a single season after its tenants have deserted it, and, in the few instances when such is the case, it will almost invariably be found, not that these exceptions to the general rule have been neglected by the clothes-moth, but that they are so situated that the wind and the rain cannot exert their full influence upon them.

Of course, no defence can be made for the moth when it enters our houses, and performs the work of destruction which has earned for it so wide-spread a reputation. In such cases, extermination is the only course to pursue. But we ought not to think, because the insect is destructive in our houses, that it is, therefore, the natural foe of mankind: nor need we imagine that every moth is necessarily a clothes-moth. Notwithstanding popular opinion, which holds that all moths without exception feed upon cloth, and that the larger the moth the more cloth, feathers, and fur it will devour, by far the greater proportion of these insects which find their way into houses are perfectly and absolutely harmless, and can cause no sort of damage either to ourselves or to our belongings. In killing them, therefore, we may very likely destroy beings which, if not actually beneficial, are at all events perfectly neutral as far as our personal interests are concerned.

# CHAPTER XIV.

## MISCELLANEOUS.

The Glow-worm—Its phosphorescent light—Mysterious nature of the light—Our ignorance of its object—Glow-worms and Toads—Difference between the sexes—The larva of the Glow-worm—Nature of its food—The *Drilus*—Rarity of the female—Dissimilarity between sexes—The *Drilus* larva—Its food—Its habitation as a pupa—A beneficial dipteron—Its services—Summary.

To all those who have ever engaged in horticulture, no matter upon how small a scale, it is unnecessary to speak of the ravages daily, or, rather, nightly, committed by the common garden Snail. They will remember only too well the manner in which their choicest flowers were visited time after time by the hungry mollusc, whose slimy tracks left no doubt of the nature of the destroyer; and there must be few indeed who cannot own to some knowledge of its powers of mischief, even though they may not have personally suffered from its depredations.

It has before been stated that no living creature is without its natural foes, which serve to keep its numbers within due limits. Nor is the snail an exception to the rule, for, setting other enemies upon one side, there are several insects which make it their special prey. One of these is the common Glow-worm (*Lampyris noctiluca*), a being whose appearance is far more familiar to us than its life-history.

There are several points of interest concerning this beetle, chief of which, of course, is the peculiar phosphorescent light which it gives forth, and which has earned for it both its popular and scientific titles.

In spite of the closest investigation the true source of this light is still wrapped in mystery. All we know is, that it proceeds from a certain fluid secreted within the body, and that it can be retained or otherwise at the will of the insect. We know also that if a glow-worm be placed in a jar of oxygen gas the light is greatly intensified; but, as this is in all probability due to the increased vitality of the insect, it scarcely helps us to draw any definite conclusions from the experiment. But we are quite unable to determine in what manner the light is caused, or what purpose it is intended to serve.

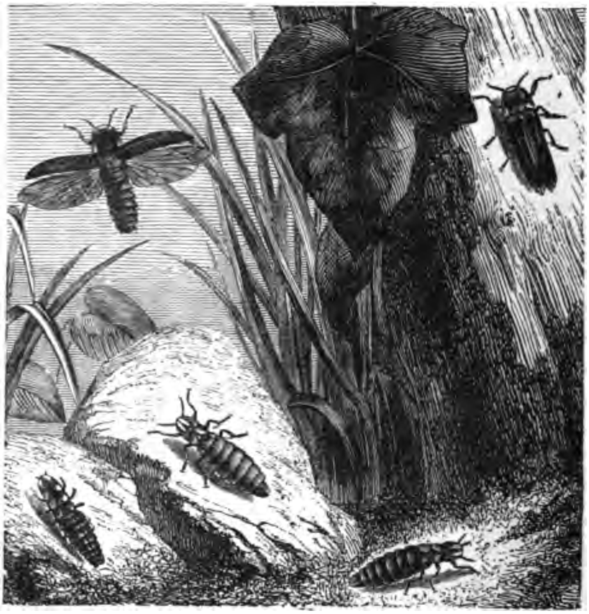
Many observers have thought that by means of this curious illumination the male is enabled the more easily to find his mate. But this theory, although plausible enough upon the exterior, will not bear looking into. For, we may ask ourselves, why, out of three thousand and odd beetles inhabiting Great Britain, two alone should be gifted in this singular manner? Many others are equally nocturnal in their habits, but are yet endowed with no special qualifications for discovering their mates, save those common to all insects.

Again, the male insect, the pupa, the larva, and even the eggs, are all more or less luminous, a fact for which it is impossible to account by accepting the above supposition. All that we can do is to plead ignorance upon the subject, and to trust that future investigators may be more fortunate than ourselves in discovering the secret of this singular property.

It would seem, indeed, that the luminosity rather tells against the glow-worm than otherwise, attracting to it the notice of toads and other insectivorous creatures which might otherwise have passed it by. I once placed some forty specimens of the insect within a fernery tenanted by two or three toads, and found that in the course of a night or two not a single one had escaped their voracious foes. It seems rather strange that the toad should not be deterred by the light emitted by the insect; but, when we read that toads will swallow fragments of red-hot charcoal without sustaining injury, our wonder immediately disappears.

I have found that the luminosity does not invariably end with the death of the insect, for upon one occasion, seeing a shining object after dark upon the floor of my room, I discovered the body of a crushed glow-worm, which had evidently escaped from a box in which I had been keeping some specimens, and which, although dry and shrivelled, yet emitted a clear although feeble light.

Few persons, upon seeing the male and the female glow-worm side by side, would imagine that they were both beetles, much less that they belonged to the same species. The nature of the male is evident enough, his wing-cases alone proving his coleopterous character. But the female is far more like a grub than a perfect insect, possessing only microscopical rudiments of wings, and bearing not the slightest outward resemblance to her active spouse. There is even a greater difference between them, indeed, than between the sexes of the Winter-Moth (*Cheimatobia*



Metamorphoses of the Glow-worm (*Lampyris noctiluca*).

*brumata*), the female of which, though almost entirely destitute of wings, bears a certain bodily resemblance to her more highly-favoured mate. In fact, with the glow-worm, almost the sole point of likeness lies in the fact that the head is in both sexes hidden away beneath the thorax, so that it cannot be seen unless the insect be turned upon its back.

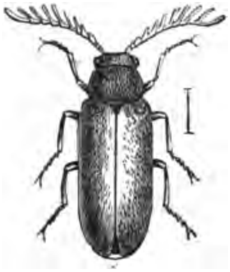
The male glow-worm is not very often seen, excepting when, attracted by the light of a candle or lamp, he makes his way into our houses after the fashion of certain night-flying moths. The female, however, is tolerably common in most parts of the country, excepting in those where a clay soil is predominant.

And that for the following reason. In a clay soil the snails are unable to procure sufficient lime from which to form their shells, and are thus, as a rule, almost entirely absent. Consequently, the glow-worm, not being able to find food within the proscribed district, is obliged to restrict itself to those localities where its prey is to be found, in order that its future offspring may have no lack of sustenance.

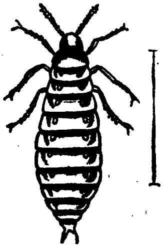
The larva of the glow-worm is wonderfully like the female imago, so much so, indeed, that it is frequently mistaken for the perfect insect. It is by no means uncommon to see communications addressed to the newspapers, in which the writer records the capture of glow-worms either at the end of autumn or early in spring. In all these cases the larva is clearly referred to, its luminosity and wonderful resemblance to the perfect insect having given rise to a very excusable mistake.

The terminal segment of the abdomen of the larva is furnished with certain tufts of hair, which not only serve as aids in locomotion, but are also highly useful in freeing the body from the slime of the snails upon which the insect feeds. During the winter this larva hibernates, secreting itself away in some recess where it may find protection from the direct influence of the chilling cold. No sooner do the snails leave their winter-quarters, however, and appear again in their accustomed haunts, than their destroyer throws off its lethargy, and continues the campaign which it commenced during the previous autumn.

IN its work of destruction the glow-worm is assisted by an allied beetle known as *Drilus flavescens*, which, at least as regards one point, is a most remarkable insect. This point lies in the extreme rarity of the female and the comparative abundance of the male, many hundreds of the latter being captured to a single example of the former.


*Drilus flavescens*
(Male).

As is the case with the glow-worm, the two sexes of the *Drilus* are very dissimilar in appearance. The male, which is a pretty and graceful little insect, is about a quarter of an inch in length, with a black head, thorax, and legs, yellow wing-cases, and comb-like antennæ. The female, however, attains to the length of half an inch, or exactly double the dimensions of her mate, and is extremely grub-like; her colour is a dull reddish-yellow, each segment having two dark patches upon the upper side, and the antennæ are small and insignificant. In both sexes the head is fully visible.



*Drilus flavescens* (Female).

The female larva is more easily distinguished from the imago than is the case with the glow-worm, a row of fleshy tubercles running along either side, while the back is decorated with a double row of hairy tufts. The tail is furnished with a forked apparatus, serving the same purpose as the hairy tufts upon the body of the larva of the glow-worm.

As is the case with the glow-worm, the larva of the *Drilus* preys upon snails, three of which it is said to devour before its growth is completed. Its change to the pupal condition takes place within the shell of its latest victim, the cast larval skin exactly filling up the entrance, and preventing the admission of foes.

In the private entomological collection of the British Museum may be seen a female larva of this insect, which was taken many years ago by Mr. E. C. Rye while running among snail shells at the foot of Shakespeare's Cliff.

These two beetles, the *Drilus* and the glow-worm, are undoubtedly of very great service to us in the destruction of snails. Numerous as those mischievous molluscs are, they would certainly be far more plentiful but for the untiring exertions of these their implacable foes; and, as in many other cases, our gratitude for the diminution of a great pest is due to creatures which we should never have imagined to exercise any beneficial influence upon us.

We now come to the last of our insect allies which can be described in the present work, namely, a tiny dipterous fly known as *Phytomyza lateralis*, whose real value has only been discovered within the last few years. The first note which I can find upon the subject is by Mr. E. A. Fitch, bearing the title of "A Beneficent Dipteron," which appeared in the *Entomologist* for July, 1880 (Ent. xiii., p. 166). From his description I have selected the following remarks :—

"In the spring of 1875 I had ten acres of red clover, which was smothered with groundsel. In April of that year I was somewhat surprised to see a very great deal of the groundsel dying away before it seeded. Upon examination, the cause of this was found to be a small dipterous maggot feeding in the pith of the lower part of the stems. I collected many of these affected plants, and bred, about the middle of May, a quantity of the little flies, which I then sent to the late Mr. Newman, but he could not get them named. They pupated in the stems. Mr. R. H. Meade, to whom I have just sent a specimen, tells me it is *Phytomyza lateralis* of Fallen. I wished for its determination, as the larvæ have again appeared in some abundance. Last winter groundsel came up very thickly in some early-sown wheat; this was hoed twice, but much of the weed still lived, and it is now dying away, owing to the attacks of these little stem-feeding larvæ. Groundsel (*Senecio vulgaris*) is a troublesome weed on our good heavy land when in high condition."

Upon writing to Mr. Fitch for further information, I was told by him that he had found the groundsel stem-feeder almost every year since the appearance of the communication from which the above extract is taken, and he also sent for my perusal a letter from Mr. Peter Inchbald, which I quote *verbatim*.

"I send you this evening," he says, "examples of the 'beneficent dipteron,' which I have again reared in some numbers from the heads, or receptacles, to speak more truly, of the *Pyrethrum inodorum*, the *Matricaria inodora* of some writers, the *Chrysanthemum inodorum* of others. The fly, as a larva, eats the pithy or succulent part of the receptacle; pupates within the cavity, which is darkened by its fading, placing itself so as to make its exit conveniently in the very top of the cone, just below the florets, but not among them. I have bred fully half a score. I have sent examples to Dr. Meade, who at once pronounced it to be *Phytomyza lateralis* (Fallen), and so identifying it, I presume, with the one you sent from the groundsel. The habits of life certainly would incline one to the belief that the larvæ are identical. In each case the grub feeds on pith, or the succulent matter of the stem. All the plants given by you have pithy stems;—'groundsel, nettle, vervein, houndstongue,' essentially so. Thus I think we must infer that it is one and the same pith-feeder that finds its support in such varied vegetation. I see you bred it in 1875. I have reared it twice, on both occasions from the wild chamomile, and both times in the month of October."

Owing, probably, to the very recent nature of the discovery of its life-history, this little fly does not seem as yet to have attracted general notice, although it is almost certainly of equal service in other parts of the kingdom. Notwithstanding the paucity of observations upon its habits, however, Mr. Fitch's notes are amply sufficient to entitle it to a high position in the ranks of beneficial insects.

BESIDES the insects which have been enumerated in the preceding pages as worthy to be considered as the allies of man, there are many which, while generally holding a neutral, or in some cases even an adverse position, yet upon certain occasions act in a manner which must cause us to regard them in a very different light. Thus the Earwig, for instance, which has been thought by gardeners and florists to be anything but a beneficial insect, has lately been detected, as previously stated, while feeding upon the cocci, or scale insects, which are so destructive in our greenhouses and hothouses, and also on the "American blight," which is so injurious to our fruit-trees. Certain hymenoptera provision their nests with the bodies of aphides, lepidopterous larvæ, and other beings which are decidedly injurious, and we might cite numberless others which occasionally act as our allies.

As the study of entomology progresses, our list of beneficial insects will increase, until finally we shall regard these little creatures in their true light,—not as the foes, but as the friends of mankind. We need not even despair of finding that such destructive beings as the aphis, the cabbage-caterpillar, and others, may yet possess some compensating properties, or may be applied to some useful purpose at present unknown, the value of which will counterbalance in some degree the losses which they cause us in other ways.

We cannot change their nature, it is true, but we may discover some peculiarity in their life-history which has hitherto escaped our notice, and which may cause them to occupy a very different position towards ourselves. For such discoveries the chief, indeed, the only requisite is a constantly-increasing band of earnest investigators, who will be content to accept the work of others as far as classification is concerned, but who will depend upon their own labours in the far more important study of the life-history and habits of the insects which they endeavour to understand. Such students will be well repaid, for they will feel the satisfaction of having performed original work, instead of merely following in the beaten track trodden by numberless predecessors. And, more than all, their discoveries may be such as to confer the highest benefits upon the human race, benefits which will earn for them the gratitude of mankind for all time.

# CHAPTER XV.

## CONCLUSION.

We have now seen how a large proportion of the insects inhabiting the world are in some way or other the friends of mankind. We have also seen, in some slight degree, how much we owe to the combined efforts of these individually insignificant beings as regards the conditions which render possible our existence upon the earth. We have seen how disease is averted by their influence, how our crops are preserved, and how our woods and forests are saved from total destruction solely by the incessant labours of insects. And we cannot doubt that, in the present incomplete stage of our knowledge upon the subject, we are as yet unacquainted with the true value of many beings which are equally serviceable with the above, although we may not yet appreciate the benefits which they confer upon us.

Without accepting the extreme theory that all living creatures were placed upon the earth solely for the direct service of man, we may yet feel assured that none were formed for the exclusive purpose of causing him injury. As a necessary consequence of our civilisation, we have many insect foes; but, setting upon one side the fact already treated upon, that these are not our natural enemies, we cannot state with any degree of certainty that the most destructive of them may not be capable of rendering to us valuable service, were we sufficiently acquainted with its life-history to recognise the particular manner in which it might prove of utility.

In the future, however, we have much to hope for. The almost daily increase in the number of working entomologists is a most encouraging sign, especially as the fact is being more and more widely acknowledged that true natural science consists, not merely in the collection and arrangement of the objects of which it treats, but in the study of the economy of their life.

Our entomologists of twenty years back confined their attention almost solely to the enrichment of their cabinets. The possession of a long series of any scarce insect was considered of far greater importance than the study of its habits, and many collectors were fully capable of exterminating any rarity whose haunts they might happen to discover, merely for the sake of adding a few specimens to their collection. Such individuals would be far wiser were they to devote their attention to the accumulation of postage-stamps, or even crests and monograms, for they are actuated, not by any desire to search out the secrets of nature, but merely with the craze for pure and simple collecting.

It is true enough that a collection of the objects which he studies is almost indispensable to the working entomologist, but there is no need of the double and even treble row of each species which are even now to be seen in some cabinets. Ask the owner of one of these collections a few questions as to the life-history of some of his more valued specimens, and he will probably be unable to tell you. He may perhaps be acquainted with the appearance of the larva and the nature of its food, but in such cases he has in all probability bred the insect, not in order to study its habits, but to obtain more perfect specimens than he could capture at large. His name may be appended to numberless communications in the various magazines, but, on investigation, it will be found that these are, without exception, mere lists of his captures, not one single observation being recorded which could benefit science in the very least degree.

Such men are not entomologists, but collectors of insects. The true object of the study which they profess to take up is to them a thing unknown. They care not whether an insect be beneficial or injurious, so long as it exercises no direct influence upon themselves, and provided that they can pin a long series of examples in their cabinets.

But, happily, such men are now in a very small minority, and we may confidently look forward to the time, not, we will hope, so very far distant, when the possession of a collection shall be considered merely as subservient to the study of the habits of the beings which it comprises.

We shall then recognise the fact that there is no insect or other creature but has its work to do in the world; that the numbers of each species, had man made no advance in civilisation, would be, broadly speaking, neither too many nor too few for the due performance of that work; and that we cannot undertake the extermination of even those beings which we may consider as injurious without serious risk of disturbing the balance of nature.

Not, of course, that we should not keep down the numbers of certain destructive insects by every means in our power. In the unnatural condition to which the world has been brought by means of civilisation, such precautions cannot but be taken. But we should condemn no creature upon insufficient evidence, nor should we persecute it beyond the point at which it ceases to be injurious to our interests. If by a single word, for instance, we could sweep the aphis or the cabbage-butterfly from the face of the earth, that word ought never to be spoken.

At each addition to our knowledge, too, we shall find cause in an ever-increasing degree to admire the grand scheme of Creation which devolves upon beings the most insignificant the important task of rendering the world habitable by others higher than themselves. Every point in the past history of the world teaches us the same lesson. Geology tells us, for example, that the very soil upon which we tread is in a great measure composed of the bodies of beings which lived and died millions of years before man existed in the world, during a period when it was unsuited for the presence of more highly-developed forms. And this is but one of the many instances of the universal rule that the lower paves the way for the higher, the work by which each supports existence thus serving a double purpose, and tending to the benefit of others besides the one by whom it is performed.

So, although insects may appear to live for themselves alone, they do so only in seeming, their presence on the earth being in very truth indispensable to the existence of higher beings.

Were the lower forms of life to be annihilated, the higher would inevitably perish for want of the services which creatures individually so insignificant, but collectively so important, had rendered to them, and which they were altogether unable to perform for themselves. Such being the case, is it not our duty, instead of destroying an insect whenever we meet with it, first to make a thorough investigation into its habits, and then, unless it be proved to be absolutely injurious to our interests, to protect and encourage it by every means in our power?

Should we do so, we shall find no cause to regret our determination, but shall, as time wears on, meet with ever-increasing cause to congratulate ourselves upon the existence of beings which so thoroughly merit the title of our Insect Allies.

THE END.

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